The SURGICAL TECHNIC *of*

ABDOMINAL OPERATIONS

The SURGICAL TECHNIC *of*

Fourth Edition Revised

ABDOMINAL OPERATIONS

By

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082 illustrations on 302 figures
mostly original

SPRINGFIELD · ILLINOIS · U. S. A.
CHARLES C THOMAS · PUBLISHER

Charles C Thomas, Publisher
Bannerstone House
301-327 East Lawrence Avenue, Springfield, Illinois

Published simultaneously in The British Commonwealth of Nations by
Blackwell Scientific Publications, Ltd.,
Oxford, England

Published simultaneously in Canada by
The Ryerson Press, Toronto

First Edition, 1936
Spanish Edition, 1937
Second Edition, 1938
Third Edition, 1940
Fourth Edition, 1946
Fourth Edition, Second Printing, 1947

Printed in the United States of America

TO MY WIFE

PREFACE TO THE FOURTH EDITION

The fact that the third edition has been exhausted within two years and there is a demand for the present edition should serve as a proof of the usefulness of the book

The present fourth edition has been revised Certain material has been eliminated and other material added The type has been entirely reset and the bibliography set in smaller type

The author takes this opportunity to express his deep appreciation to many readers for kind expressions about the book He also wishes to express his thanks to the publisher, Mr Charles C Thomas, for his readiness to carry out the author's wishes in the preparation of the book

It is to be hoped that the present fourth edition will receive the same kind reception that has been accorded preceding issues

JULIUS L SPIVACK

PREFACE TO THE FIRST EDITION

This book is an outgrowth of lectures on Operative Surgery as delivered by us for many years to our students, both undergraduate and postgraduate

No apology is needed for writing a book on Surgical Technic The great number of books on surgery usually deal with "what to do," and very little emphasis is made as to "how to do," probably because it is taken for granted that the reader knows "how to do it," which knowledge he acquired in the time of apprenticeship We do not consider for a moment that this book can replace apprenticeship On the contrary, we believe that a book of this type can render the most service while the beginner is studying the technic of operations on cadavers, living animals, or by actual assistantship For this reason, we believe this book to be useful for medical students while they study operative technic on cadavers and on living animals, just as well as for a busy practicing surgeon who wishes to review in detail the technic of the operation he is going to perform

The subject is presented in a didactic manner At the beginning simple procedures are presented with numerous pictures, farther on, more complicated operations are described, and only such pictures are added which enable the reader to grasp at once the correct sequence of the steps of the operation under discussion

In many chapters a brief historical review of the evolution of the operation is given This makes it possible for one to study the mistakes made by our predecessors, thus enabling us to learn how to overcome them Wherever possible, we have mentioned the name of the originator of the operation, and have tried as well as we could to establish the priority of the man who described this or the other method More than one technic for each type of operation is described for the reason that we believe that the surgeon should be familiar with more than one method, so that he can choose *the type of technic suitable for the particular occasion*

In the title of many operations we have retained the name of the originator, although the text we have used may deviate in some details from the text as written by the originator of the method, and may include some improvements made later by someone else

Our desire to present only modern methods of operative treatment did not prevent us from describing some appliances which are seldom used now, such as the Murphy button The reason for this is, that still under definite circumstances some surgeons are using the button even today, and another reason is that many times we have been requested by postgraduate students to demonstrate its use However, describing its use in detail, we

emphasize our belief that suture methods should be given preference to all other methods in which mechanical appliances are used.

The bibliography contains not only references to recent work published, but also "old" literary work. The reason for this is evident. We are giving first of all the references to the original work of the authors who laid the foundation for this or the other operation. The bibliography does not refer only to subjects dealing with the technic; it refers also to all other subjects discussed in the book, such as anatomy, indications, dangers connected with the execution of the operation, etc.

To Dr. W. A. Newman Dorland, of Chicago, we wish to express our deep appreciation for his invaluable suggestions and wise counsel.

To Dr. Karl A. Meyer, of Chicago, we wish to express our thanks for the kindly interest shown throughout the preparation of the book.

The illustrations are, with few exceptions, original. The pictures have been drawn by Miss A. Bartenbach, the medical artist of Cook County Hospital, Miss F. Foy and Messrs. G. Dalstrom, G. Orloff, and G. Vollum. We wish to express our thanks to them for their excellent and painstaking work.

JULIUS L. SPIVACK.

Chicago, Illinois

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PART I

CHAPTER I

GENERAL SURGICAL TECHNIC IN THE ABDOMINAL CAVITY

GENERAL CONSIDERATIONS PERTAINING TO ABDOMINAL SURGERY

Every operation, no matter how complicated and extensive, consists of a combination of two simple procedures, namely, division and union of tissues

In order to perform a satisfactory operation, from the technical point of view, several factors have to be taken into consideration

1 The tissues should not be mutilated and should be handled very gently

This can be accomplished by using sharp knives or scissors and by not mauling the tissues

2 The bleeding vessels should be grasped with as little of the surrounding tissues as possible

3 Constant practice by the surgeon of the different essential elements of the operative technic, such as suturing and tying knots

There is hardly any profession in which manual dexterity is of importance in which its members engage in the development of their technical *skill as little as does even the busy surgeon*

4 Each step of the operation should be familiar to the surgeon before he starts any operation

He should never start an operation that he has never performed before unless he has done it on a cadaver and on living animals

5 Time element is of no great importance provided that it does not overstep a reasonable limit

For the average major operation 45 minutes up to 1 hour is good time (including opening and closure of the abdomen) Of course, the appendectomy should not take one hour, and certainly one is allowed more than one hour for a gastrectomy *The length of the operation does not depend so* much on quick movements as it does on standardized technic The surgeon should learn to make each movement accomplish a definite purpose

6. The operative field should always be well exposed and accessible. This means that it should be brought as close to the surface of the skin as is possible and be well illuminated. This simplifies the performance of the operation.

7. All bleeding points must be controlled.

8. Dead spaces must be avoided.

9. The surgeon should not change the posture of his body. He should not lean over the patient's body, compressing the latter's chest. He should not push his assistants aside or obscure the operative field from his assistants. All these things can be accomplished either by changing hands (which means that if the surgeon cannot accomplish a movement with his right hand, then he should use the left hand instead and *vice versa*) or instruments (scissors instead of knife and *vice versa*).

LIGATURES AND SUTURES

Suture-material is used for the approximation of the edges of incised tissues and for the ligation of blood-vessels. If it is used for ligation of blood-vessels it is called a ligature, and if for holding the approximated tissues together, it is called a suture.

Historical

Ligatures and sutures have been known from remote antiquity. In the Edwin Smith Papyrus, written about 4,000 years ago, we learn that the surgeons of Egypt were accustomed to close opened wounds by adhesive plaster made from strips of linen, and reinforced by sutures.

Susruta (600 B. C.), who is considered the father of Hindu surgery and who is the author of Samhitá, taught closure of the open abdomen with sutures, and as suture-material used cotton, strips of leather, plaited horsehair or animal sinews.

Archigenes of Apamea, a great Syrian surgeon who lived about 100 A. D., taught ligation of the large blood-vessels before amputating the extremity. From the writings of Celsus and Galen we learn that they knew well the usage of ligatures and sutures.

In the Medieval Period, Rhazes, the great Arabian surgeon of Bagdad (860–932), was the first who sutured the open abdomen with harp-strings which were made from the twisted intestine of the sheep.

In the time of the Renaissance, Guglielmo di Salicetti, the surgeon who introduced the "glover suture" in intestinal surgery, knew the comparative merits of silk and waxed linen thread as material for the ligation of blood-vessels.

Leonardo Bertapaglia (XV Century), of the School of Padua, taught isolation of blood-vessels before their ligation, instead of ligating them "en masse," as was customary at that time.

However, the ancient and medieval surgeons preferred the cautery and boiling oil to ligatures as hemostatics, and strips of adhesive plaster to sutures as suture-material.

The credit for reviving the interest in ligatures belongs to the great French surgeon-barber, Ambroise Paré (1509–1590), formerly prosector for the great anatomist Sylvius, and later court surgeon to the French Kings —Frances II and Charles IX. The ligature was more extensively used in Continental Europe; in England it was not much in use until the beginning of the nineteenth century. To Mr. Sharpe, of Guy's Hospital in London, belongs the credit of popularizing its usage in England.

Suture material for suturing of wounds came into use much later than the use of ligatures, in fact not until the first half of the nineteenth century. Up to the first quarter of this century, surgeons used strips of adhesive plaster for the closure of wounds, even of the opened abdomen.

All suture-material can be divided into two large classes:

A. **Absorbable sutures;**

B. **Non-absorbable sutures.**

A. **Absorbable sutures.**—These are so named because when left in the tissues of the body for a short time (1 to 4 weeks) they are dissolved. They are all of animal origin. They are made from the tendons of different animals, such as the kangaroo, or rat, from the aorta of the ox, from the intestinal wall of sheep, etc.

Catgut actually replaced all other kinds of absorbable suture. It is made from the submucous layer of the intestinal wall of the sheep.

Catgut occurs in different forms, depending on the method of its preparation and of the component parts of the chemicals by which it is treated. It is prepared in different sizes. Each size has a definite diameter and is three one-thousandths of an inch (0.0762 mm.) larger, than the next smaller one. Thus, the size of catgut is standardized as follows:

For number 000—the size is 0.2286 mm. (nine one-thousandths of one inch).

For number 00—the size is 0.3048 mm. (twelve one-thousandths of one inch).

For number 0—the size is 0.3810 mm. (fifteen one-thousandths of one inch).

For number 1—the size is 0.4572 mm. (eighteen one-thousandths of one inch).

Catgut is manufactured in sizes 000-00-0-1-2-3-4-5-6-7, the sizes most commonly used are 00-0-1-2-3.

Depending on the method of chemical treatment, catgut is subdivided into:

a. *Plain catgut.* This is catgut which has not been treated with any

reagent that would in any way increase its ability to resist absorption.

b. Chromic catgut. This is plain catgut suture which has been treated by chromium trioxide. The object of chromicizing catgut is to render it more resistant to tissue fluids and thus delay its absorption. It is customary to name chromic catgut as "ten-day," "twenty-day," or "forty-day"—the number of days designating the length of time which is necessary for the catgut to be absorbed in a normal striate muscular tissue.

c. Iodine catgut. This is catgut which has been immersed in a solution of iodine and iodide of potassium. The object of using iodine catgut is to have a suture-material which exerts a local germicidal action in the tissues and thus prevents the suture from bacterial invasion, which would hasten absorption of the catgut and also delay the healing process.

d. Iodochromic catgut. This is plain catgut which has been treated with a solution of iodine, potassium iodide, and potassium dichromate.

e. Silverized catgut. This is plain catgut which has been treated with silver, which increases its strength and delays its absorption.

The length of time that is needed for the absorption of catgut depends on numerous conditions: it is absorbed more rapidly in infected than in healthy tissues. The absorption period varies in relation to its size, to the morphological type of tissue in which it is buried (peritoneum, muscle, fascia) and to the degree of impregnation with chromium salts.

The tensile strength of catgut depends on its size and whether it is plain or chromicized. It slightly differs with the method of preparation, and for this reason slightly differs with each manufacturer.

The strength of plain catgut is approximately as follows:

For size 000— 3 lbs. is the breaking point.
For size 00— 4 lbs. " " " "
For size 0— 7 lbs. " " " "
For size 1—10 lbs. " " " "
For size 2—14 lbs. " " " "
For size 3—19 lbs. " " " "
For size 4—21 lbs. " " " "

Kangaroo tendon is obtained from the tail of a kangaroo; it is very strong; the fine size has a tensile strength of about 27 pounds; the medium size about 38 pounds; and the coarse about 50 pounds. It absorbs very slowly. It was used quite extensively in former years for the repair of hernias, but is not used much today in abdominal surgery.

Recently other varieties of soluble suture-material have been introduced by different surgeons. Although we give a brief description of them, we believe that their value is not sufficiently established yet and a more prolonged study of them is necessary.

Carnofil is a soluble suture-material prepared by Bost from the muscles

of a horse This suture is even, wiry and flexible Its tensile strength is great a strand of 0 5 mm in diameter withstands a tension of 3 3 lbs (1 5 kg) and a strand of 0 8 mm in diameter withstands a tension of 24 2 lbs (11 kg) It may be subjected to unlimited sterilization without impairment of its properties It absorbs well and it does not produce anaphylaxis, except in sensitized animals

Nerves as suture material were introduced by Preobrazensky The nerves are treated with 20 per cent acetic acid, twisted, dried and sterilized in 2 per cent brilliant green Absorption takes place in 12 to 14 days It is used for intestinal suturing

To the soluble sutures belong also different types of "living sutures," that is, strips of aponeurosis or tendons which are still connected with the mother tissue and used for suturing purposes As examples of this type of suture we may mention repair of hernia by strips of the aponeurosis of the external oblique muscle, fixation of the stomach to the anterior abdominal wall by the round ligament of the liver, fixation of the uterus to the anterior abdominal wall by the round ligaments of the uterus, etc

B **Non-absorbable sutures** —Non-absorbable sutures are those which do not dissolve when left in the body, they stay indefinitely They are either of

1 **Inorganic nature—metallic sutures**

Metallic sutures were used extensively in the pre antiseptic days, later, they were nearly discarded However, recently interest in them has been revived, and they are now used by some surgeons in nearly all countries They have definite advantages and disadvantages over other types of sutures The advantages are that the abdominal wall can be closed very rapidly, the wires may be loosened if they constrict the wall too much, and are reapplied without destroying the action of the individual suture The disadvantages of metallic sutures are that occasionally the patients complain of pain until the sutures are removed, occasionally the metallic sutures cut through the skin, thus leaving scars

a **Gold**, in the form of wires On account of the high cost they were used very little and now not at all

b **Silver**, in the form of silver wire, is now seldom used in abdominal surgery In pre-antiseptic days it was used quite extensively It finds its application even now in orthopedic surgery

c **Combination of different metals (Alloys)** Michel clips are used for closure of the skin of the abdomen, the Murphy button is occasionally used for anastomosis of two hollow viscera

Stainless steel wire was recommended by W Babcock for closure of the skin and also as tension sutures According to him, the steel wire is less brittle than silver or bronze wire and is strong, smooth, non irritating and inexpensive

Nickeline is an alloy which was introduced by Minine. It is used chiefly in gynecological operations and for the closure of the abdominal wall.

2. **Organic of vegetable nature.**—Linen is used now quite extensively. In the form of the Pagenstecher celluloid thread, it is an excellent suture-material. It is much stronger than silk of the same diameter and for this reason it can be used in smaller sizes. It is easily disinfected by boiling, and it is much cheaper.

In recent years cotton has become a widely used suture material. Thousands of cases have been reported where it has been used for varied operations with gratifying results. The cotton possesses pliability, adequate tensile strength, and stability on exposure to heat and moisture. It produces less tissue reaction than silk, linen or catgut.

Three sizes of spool cotton are adequate: size No. 60 for ligature of small vessels and for suture of wounds where the cosmetic result is important; size No. 40 for closure of peritoneum, suture of gastro-intestinal tract, subcutaneous suture and skin; size No. 20 for suture of fascia and ligation of large vessels.

Most of the surgeons using cotton recommend the use of interrupted sutures, although some use continuous sutures for the peritoneum and skin, and interrupted for the rest.

It has been shown that wounds closed with spool cotton have less induration, edema and tenderness as compared with wounds closed with other suture material.

3. **Organic of animal nature.**

a. Silk, braided or twisted. This is strong, particularly the braided variety. It is easily sterilized. It is pliable, does not swell when placed in the tissues, and does not irritate them; it is easy to tie; the knots are tight and have little tendency to slip. However, its capillarity makes silk unsuitable for skin closure, since it may act as a wick to carry infection into the deeper tissues.

b. Silkworm gut is prepared from the silk-forming glands of the silkworm. It is easily sterilized by boiling, which softens it and renders the tying easy. It is best used for tension-sutures. It should never be used as a buried suture.

c. Horsehair is obtained from the tail of a horse. It is light and flexible but has great capillarity. It is very breakable, so that it will not stand much tension. For this reason, it is advisable to use it only for skin-suturing in cases in which silkworm-gut tension-sutures are also placed, so that the horsehair is holding only the edges of the skin-wound in approximation. In tying them no great force should be employed, since they will break if the pulling force exceeds 1½ lbs. It should be kept in mind that horsehair requires a thorough sterilization on account of a possibility of the presence in it of the resistant *Actinobacillus mallei.*

d. **Dermal** is made of pure silk threads carefully spun from selected silk-fibers and finished by special processes Dermal is characterized by a greater tensile strength than horsehair It can be boiled for sterilization purposes It is twice as strong as horsehair of the same diameter, and for this reason is preferable to horsehair for suturing of the skin

e **Kal-dermic** is used for skin and tension-sutures It is a silk thread which has been subjected to special treatment by chemicals to render it resistant to the action of the body fluids and to capillary action This suture is strong, flexible and non-irritating

Selection of suture-material

In selecting the suture material, the surgeon is guided by several considerations The suture material should be easily sterilized, and while being sterilized it should not lose its properties, such as tensile strength, it should be pliable, it should be of sufficient tensile strength to hold the tissues together until union takes place, it should not be bulky, it should become absorbed as soon as the need for it has passed There is not a single type of suture-material which satisfies all these requirements, and for this reason it is extremely difficult to decide—which material should be given preference—absorbable or non-absorbable

The advantage of catgut (soluble material) is in its absorbability The disadvantage of it is that it is difficult to sterilize it, cases have been reported of severe wound infection, such as tetanus or gas bacillus infection which could be traced to contaminated catgut Occasionally, there is severe irritation of the tissues by the chemicals used for sterilization of catgut Cases have been reported of allergic action of catgut in susceptible patients This action has been manifested by different clinical symptomocomplexes, such as asthma, or by a very quick absorption of the catgut before union of the tissues has taken place, with ensuing evisceration of the abdominal contents after laparotomy The advantages of insoluble material are · it can be easily sterilized by boiling, its tensile strength is greater than that of a corresponding thread of soluble material, it is more pliable, the knots are less bulky

The disadvantage of insoluble material is that it remains in the tissues as a foreign body In many cases this is of no importance, however, occasionally it irritates the tissues and if the wound becomes infected, the insoluble material may become infected, harbors the micro organisms and becomes the main cause which will prevent the healing of the wound

The majority of surgeons prefer to use absorbable suture-material However, quite recently several articles appeared from different clinics in which the authors have been advocating the use of non absorbable suture material

In our work we use soluble material (plain and chromic catgut) for

suturing the abdominal wall and tying even the largest blood vessels, and also in all gastro-intestinal work when suturing the mucosa only, or when making over-and-over sutures in which all the layers of the gastric or intestinal wall are included.

We use non-absorbable material in suturing the serosa or sero-muscular layer of the gastro-intestinal tract, in which case we use the Pagenstecher celluloid linen-thread. The skin should be sutured by non-absorbable material, because skin-sutures cannot be safely removed before from 7 to 9 days. Absorbable suture-material when placed in the skin begins to deteriorate before the 7 to 9 days; therefore it contaminates the wound. For skin-suturing, we use horsehair, dermal, or Michel clips.

NEEDLES

In suturing the anterior abdominal wall, we use both straight and curved needles. For suturing the peritoneum, transversalis fascia and muscles, we use round curved needles; for suturing the fascia, sharp curved needles; for sewing the skin, sharp curved or sharp straight needles.

In sewing the gastro-intestinal tract, we use straight or curved round needles. The essential thing is that the point of the needle should be round; if it is sharp it will cut the tissues. For most purposes, the straight round needles will serve; only in some particular cases, when it is necessary to work deeply, curved needles will be more convenient. When working with straight needles, it is not necessary to use a needle-holder; when working with curved needles, we may or may not use a needle-holder. The work without a needle-holder is more precise because the surgeon can feel exactly how deep he is going into the tissues. Usually, surgeons working with curved needles use a needle-holder, but some use their fingers instead.

KNOTS

The following are the knots which are most commonly used in surgery:

1. Square knot (Reef knot, Sailor's knot) (Fig. 1, a).

This can be recognized from other types of knots by having one vertical limb of the loop pass in front of and the other vertical limb behind the horizontal limbs. This knot is the most reliable; there is no tendency to untie; it resists pressure from inside more than any other knot (with the exception of the surgical knot); however, before it is completed, namely after only the first "half-hitch" is made, it may occasionally slip; for this reason, when working deeply in the abdominal cavity, and especially if the field is not entirely visible, it may be necessary to make a:

2. Surgeon's knot (Surgical knot) (Fig. 1, c).

This knot differs from the previous one in this respect only—that when the first half-hitch is made, the ends are not pushed away from each other, but another half-hitch is made in the same direction. Then the ends of the

thread are pushed away from each other. This constitutes the first half of the surgeon's knot. The second half of the knot is made by turning the ends in the opposite direction so as to make it a square knot. The details of how to make this knot will be given below. This knot has only one ad-

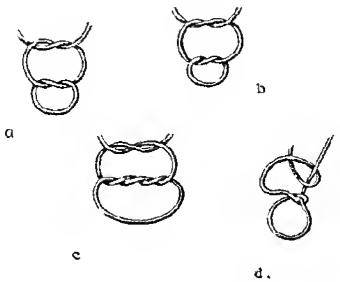

FIG 1. a —Square knot, b —Granny knot, c —Surgical knot, d —Slip knot.

vantage over the square knot, namely, that it does not slip away before it is completed. However, it does not constrict the tissues tighter than a square knot. Its disadvantage is that it is more bulky. In former days it was considered an excellent knot for ligation of blood-vessels. Now, this knot is very seldom used, and even in ligation of large arteries, it is not used very much. Its usefulness now is only in cases when a blood-vessel has to be tied deep in the field, when even the point of ligation is not well seen.

3. Granny knot (Fig. 1, b).

In this knot, each of the vertical limbs passes in front of one of the horizontal limbs and behind the other horizontal limb. This knot is only a little less dependable than the square knot. Its resistance to pressure from

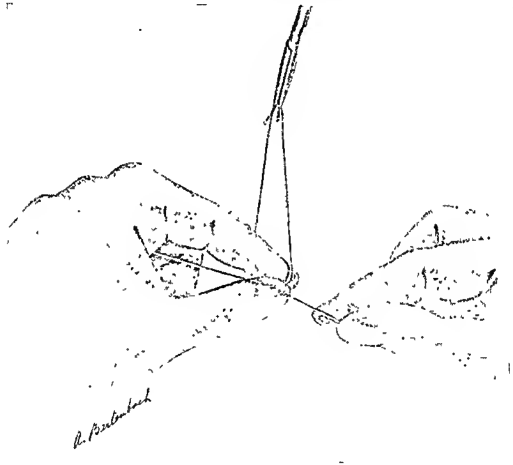

FIG. 2. Making the first turn of a square or granny knot; the index finger is within and the thumb outside the loop.

within the loop is somewhat less than in the case of the square knot; however, the ends can be more easily untied than can the square knot, probably because they are not bent so sharply back upon themselves in the same plane as they are in a square knot. For this reason, if a large artery is tied, it is best to do it by a square knot, and if a granny knot is employed, then it is advisable always to make the third "half-hitch" in the same direction.

4 Slip knot (Fig 1, d)

This is produced by pulling tightly on one end of the thread, while making a loop with the other end around the taut end as around an axis, and failing to cross the ends in the opposite direction when each half-hitch

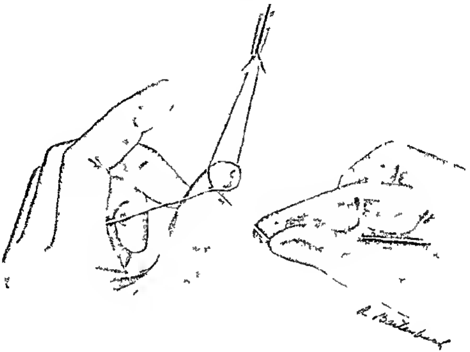

Fig 3 Making the first turn of a square or granny knot the thumb is turned upward and lies in the loop

of the knot is made It is a very unreliable knot It is surprisingly easily produced when the operator makes, as he thinks "a one finger granny knot" Even if the surgeon adds the third and fourth 'half-hitch" in the same way, it will not strengthen the knot This can be easily verified by making the half-hitches around an artery forceps and later opening the jaws In the case of the square and granny knots, the operator will be unable to separate the blades from each other

THE TECHNIC OF TYING KNOTS WITH TWO HANDS

Square knot.

In order to make a square knot with both hands, the short end of the thread is held in the right hand between the thumb and the forefinger and the long end in the left hand between the thumb and the forefinger; the

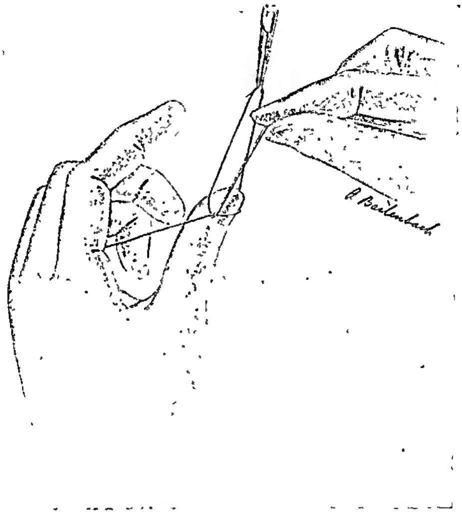

Fig. 4. Making the first turn of a square or granny knot; the short end of the thread is laid on the thumb of the left hand.

short end is placed beneath the long end and so directed that it will cross the long end at the point where the thumb and index-finger of the left hand are situated. With the index-finger and the thumb of the left hand the two threads are grasped at the point of their intersection, so that the index-finger will be within the loop and the thumb outside the loop (Fig. 2); the thumb is then turned upward so that it will be in the loop (Fig. 3).

With the right hand the short end of the thread is laid on the thumb of the left hand (Fig 4) and is compressed with the index finger of the left hand The index-finger of the left hand is turned downward, it will then push out of the loop the thumb and the short end of the thread which is resting upon it (Fig 5) This will complete the first "half hitch" of the

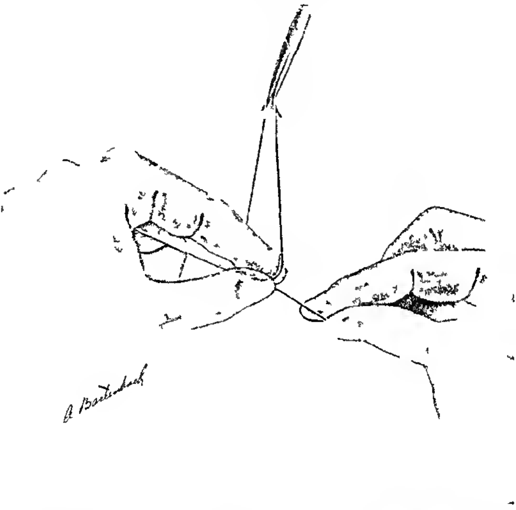

FIG 5 Making the first turn of a square or granny knot the index finger pushes the thread out of the loop

knot (Fig 6) In order to make another "half-hitch" of the square knot, the long end of the thread is held in the left palm and put on the stretch, the dorsum of the first phalanx of the left thumb moves proximally behind the thread (Fig 7), with the index finger of the left hand the short end is moved until it crosses the long end and rests on the proximal phalanx of the left thumb (Fig 7) Then the left index-finger will be inside the loop and the

left thumb outside (Fig. 7); with the left thumb the point of intersection of both ends is grasped (Fig. 7, insert), and this thumb moves inside the loop (Fig. 8). The short end is then caught by the right hand (Fig. 8), and the second "half-hitch" is thus completed (Fig. 8, insert).

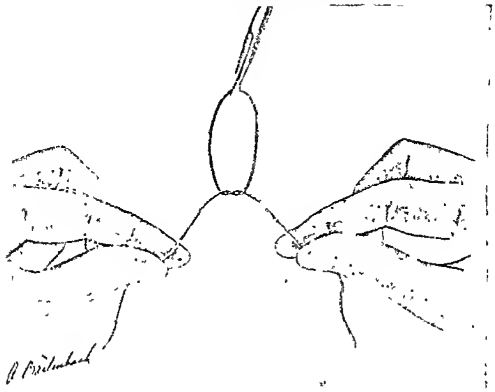

Fig. 6. Making the first turn of a square or granny knot; the first turn is completed by drawing the ends of the thread apart.

Surgical Knot.

The surgical knot consists of two turns in the first "half-hitch," and another "half-hitch" consisting of one turn is made in the opposite direction.

Granny Knot.

This is made in the following way: The first "half-hitch" is done

exactly as in the first half of a **square knot** (Figs 2 to 6), this is repeated for the second half

TYING THE KNOTS WITH ONE HAND

Square Knot

The short end of the *thread is grasped* between the terminal phalanx of the left index finger and the **thumb about four** inches from its end, so

Fig 7 Making the second turn of a square knot

that it rests on the palmar surfaces **of the** second phalanges of the middle and fourth fingers while the end **of the thread** hangs down between the fourth and the fifth fingers (**Fig 9**) [**The left hand** *is in a position midway* between pronation and supination] **The long** end of the thread, which is

held between the thumb and index-finger of the right hand is brought beneath the ulnar surface of the second phalanx of the fourth finger of the left hand, so that both ends of the thread touch each other, thus forming a

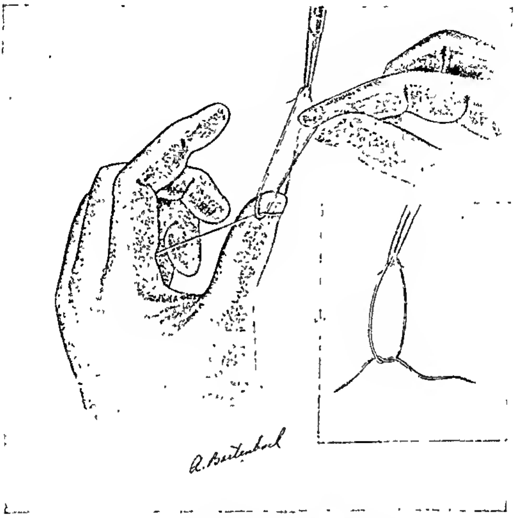

FIG. 8. Making the second turn of a square knot.

loop; the middle and the fourth fingers are inside of this loop (Fig. 9). The terminal phalanx of the fourth finger of the left hand is then bent to such an extent that the short end of the thread rests on the dorsal surface of the first phalanx of the fourth finger. As a matter of fact, the short end of the thread lies now between the dorsal surface of the terminal phalanx of the fourth finger and the volar surface of the terminal phalanx of the third finger. This short end is now grasped by these two phalanges (Fig. 10) and is carried through the loop (Fig. 11). This will complete the first half of the square knot. The second half of the knot is done in the following manner:

The short end of the thread is grasped between the thumb and the index finger of the left hand and put on the stretch, the third and the fourth fingers of the left hand are held together, the ulnar side of the fourth finger of the left hand is placed upon the short end of the stretched thread, so that these two fingers are in a position midway between pronation and

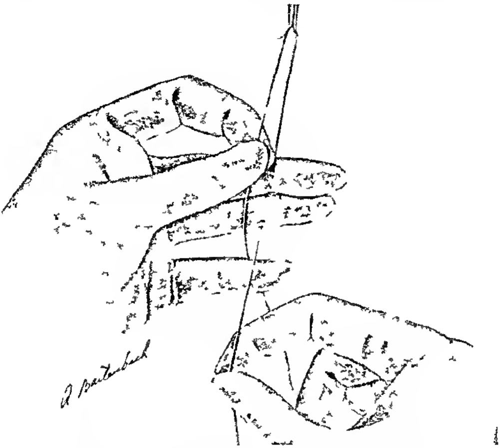

Fig 9 One hand knot Starting the first turn of a square or granny knot

supination The long end of the thread, which is held between the thumb and index finger of the right hand, is placed on the radial side of the middle finger of the left hand (Fig 12), so that the ends of the thread cross each other, a loop is thus formed, within which lie the left middle and fourth fingers, the middle finger of the left hand is bent at its terminal joint, so that the thread which is held between the index finger and thumb of this hand will rest on the dorsum of the terminal phalanx of the middle finger (Fig 13) Then this terminal phalanx is straightened, so that the thread will be caught between the third and fourth fingers of the left hand, which is carried through the loop

Granny Knot.

The first half of a square knot is twice repeated.

OTHER METHODS OF TYING KNOTS WITH ONE HAND

Square Knot.

The first half of the knot is made in the following manner:

The short end of the thread is grasped by the thumb and middle finger of the left hand; the radial side of the terminal phalanx of the index-finger

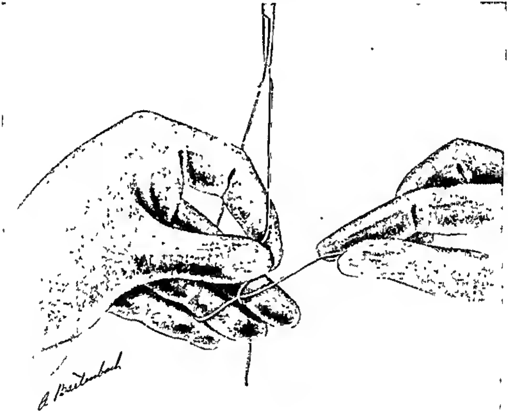

Fig. 10 One-hand knot. The short end of the thread, grasped by the middle and fourth fingers, is ready to be drawn through the loop.

is placed behind this end of the thread; the long end of the thread is grasped by the right hand, and is put on the stretch close to the ulnar side of the terminal phalanx of the left index-finger so that the two ends form a loop inside of which lies the index-finger. The middle phalanx of the left index-finger is bent so that the volar surface of the terminal phalanx of this

finger touches the volar surface of the head of the second metacarpal bone. The terminal phalanx of the index-finger is now moved away from the volar surface of the head of the second metacarpal bone in such a manner that its dorsal surface touches the short end of the thread at some point between the point of crossing of the two ends of the thread and the point

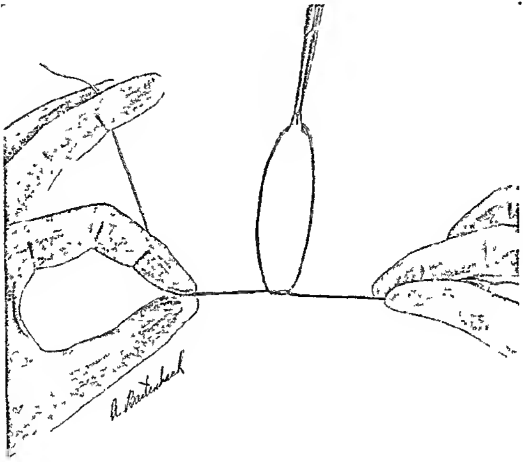

FIG 11 One hand knot The thread drawn out from the loop by the middle and ring fingers, is grasped between the index-finger and thumb

held by the thumb and middle finger (Fig 14); the terminal phalanx of the left index-finger is now completely extended, so that it again enters the loop (Fig. 14, insert). The thread resting on the dorsal surface of the index-finger is now grasped by the left index and middle fingers and the ends of the thread are drawn apart. This is the first "half-hitch" of the knot.

The second half of the knot is made in the following manner:

The short end of the thread is grasped between the thumb and index-finger of the left hand and put on the stretch. The ulnar side of the middle phalanx of the left middle finger is laid on the short end of the thread; the long end of the thread, caught between the thumb and index-finger of the right hand, is carried to the short one until they form a loop, inside of

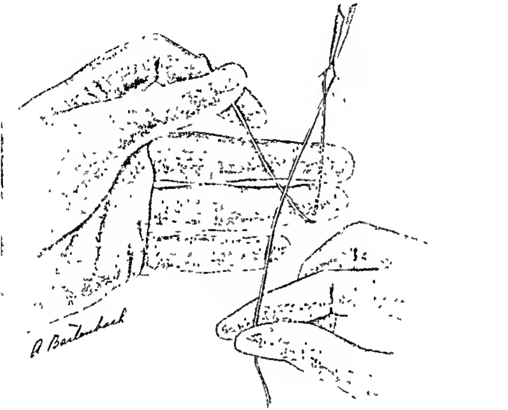

FIG. 12. One-hand knot. Starting the second turn of a square knot.

which lies the middle finger. The middle and the distal phalanges of the left middle finger are bent so that the volar surface of the terminal phalanx of the middle finger touches the volar surface of the head of the 3rd metacarpal bone. The terminal phalanx of the middle finger is now moved away from the volar surface of the head of the 3rd metacarpal bone in such a manner that its dorsal surface touches the short end of the thread at some point betweeo the point of crossing of the two ends of the thread and the point held by the thumb and the iodex-finger (Fig. 15). The middle and the terminal phalanges of the middle finger are now extended so that the middle finger re-enters the loop; the short end of the thread lying on the

dorsal surface of the middle finger is now grasped between the middle and the fourth fingers of the left hand and drawn out of the loop (Fig 13).

Granny Knot.

The first "half-hitch" of the square knot is repeated by one finger (Fig 14)

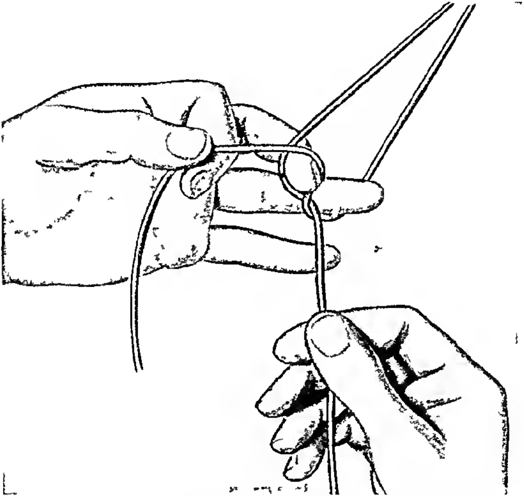

Fig 13 One-hand knot The thread is resting on the dorsal surface of the terminal phalanx of the left middle finger

TYING KNOTS WITH A THREAD ON ONE END OF WHICH IS ATTACHED AN ARTERY-FORCEPS

Square Knot.

The artery-forceps is held in the left hand and the free end of the thread is grasped between the index-finger and thumb of the right hand and

is placed to the side of the forceps proximal to the surgeon; thus a triangle is formed. The thread is pressed to the forceps by the left thumb and its free end is turned around the forceps by the right hand. The thread is now pressed to the forceps by the index-finger of the left hand (Fig. 16), and then is pushed downward by this finger and caught by the right hand (Fig. 16). This completes the first half of the square knot. The second half

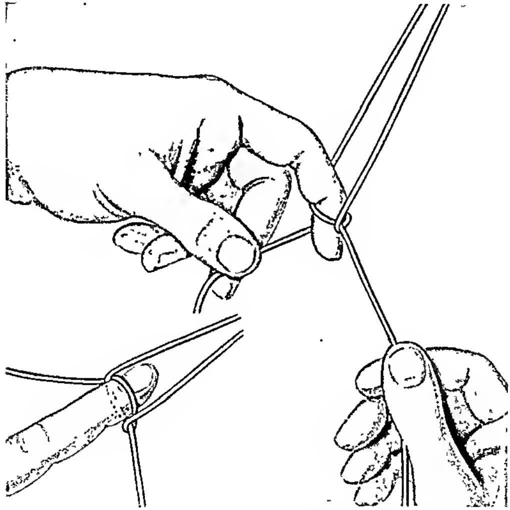

FIG. 14. One-hand knot.

is made in the following way: The free end of the thread is brought to the side of the artery-forceps which is distal to the surgeon. The index-finger presses the thread against the clamp; the thumb pushes the free end of the thread into the triangle where it is caught by the thumb and index-finger of the right hand.

This tying by artery-forceps is very economical; with the same material

one can ligate at least four times as many bleeders with the thread and attached forceps as by the "both hands" method

Granny Knot

The first half of the square knot is repeated (Fig 16)

In case one end of the thread is very short, so that it is difficult or even

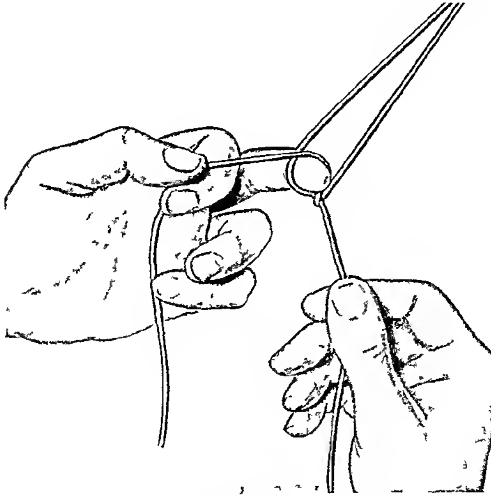

Fig 15 One hand knot The thread is resting on the dorsal surface of the terminal phalanx of the left middle finger

impossible to make a knot with two hands, this can be accomplished by *the help of tissue forceps* (Soresi *method*) *or an artery forceps* (Grant method)

TYING A THREAD WITH ONE VERY SHORT END (GRANT METHOD) (FIG 17)

The long end of the thread is held in the left hand and the short end

is clamped by an artery-forceps; a second artery-forceps is laid across the long end of the thread (Fig. 17), and loops this around itself (Fig. 18); the short end of the thread is then caught by the forceps and drawn through the loop (Fig. 18, insert); this will make the first half-hitch. To make the other half of the square knot, the artery-forceps is placed behind the same

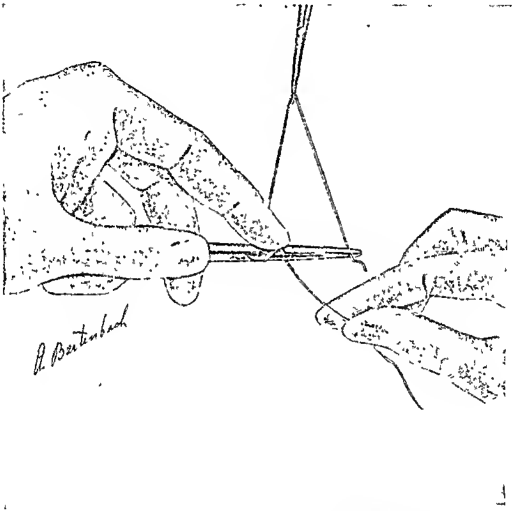

Fig. 16. Tying knots with a thread on one end of which is attached an artery-forceps

thread (Fig. 19) and all the steps are repeated. This method is also very economical. Other advantages are that it can be used deep in the abdominal cavity where there will not be enough room for the hands; and it is also applicable in those cases in which the surgeon does not wish to touch the ligature with his gloved hands at all. Then, it becomes a "No hand touch technic" (Fig. 20).

TYING OF A LIGATURE BY A "NO HAND TOUCH TECHNIC" (FIG. 20)

An artery-forceps clamps each end of the thread; a third clamp is laid in front of the thread; a loop is made with the aid of this clamp as described before and as shown in Fig. 18.

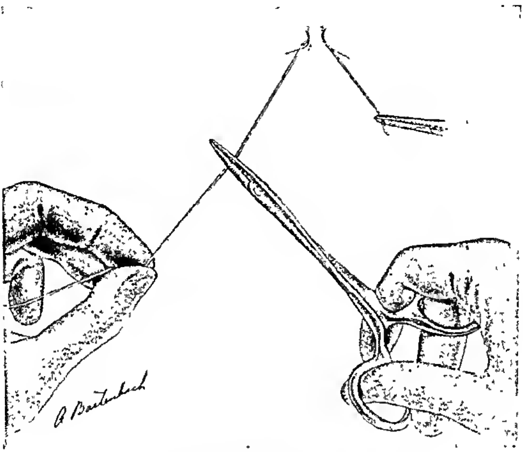

FIG. 17. Tying a short end by an artery forceps (first turn). The clamp is laid on the thread.

METHOD OF TYING A THREAD ON ONE END OF WHICH IS A CURVED NEEDLE AND ON THE OTHER END AN ARTERY-FORCEPS

The artery-forceps is held in the left hand and the needle in the right hand so that the thumb rests on the concave surface and the index-finger on the convex surface. The portion of the thread attached to the needle is brought to the surgeon's side of the forceps so as to form a triangle, the sides of which will be each end of the thread and the base the artery-forceps (Fig. 21). The thread is now pressed to the artery-forceps with the left thumb. The needle is passed through the loop with its eye directed toward the surgeon. The eye of the needle is then caught by the left index-finger

and pressed to the forceps (Fig. 21). The needle is now caught by the right hand and brought out. The first half of the knot is thus completed.

The second half is done in the following manner:

The thread on the needle is brought to the side of the forceps away from the surgeon and held in position by the index-finger; the needle is brought through the loop with the point looking forward (Fig. 22).

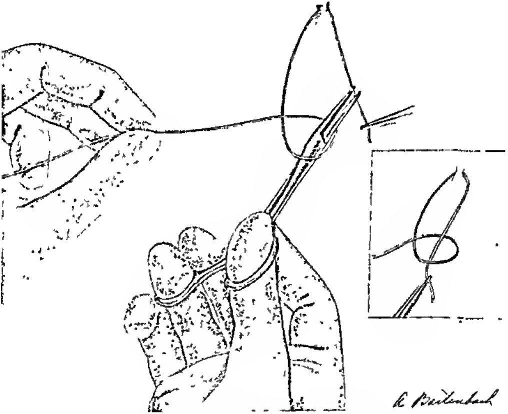

FIG 18. Tying a short end by an artery forceps (first turn).
The artery forceps forms a loop.
Insert. The end of thread is drawn from the loop.

This type of tying is also very economical; with a thread 20 inches long one may easily tie twelve times.

METHOD OF TYING A THREAD ON ONE END OF WHICH IS A STRAIGHT *NEEDLE AND ON THE OTHER AN ARTERY-FORCEPS*

The steps are the same as with a curved needle.

METHOD OF TYING AS A SEAMSTRESS (OVIATT METHOD) (FIG 23)

TRANSFIXED LIGATURES

Transfixed ligatures are those which pass through the thickness of the tissues and constrict the mass from the center to the periphery They are

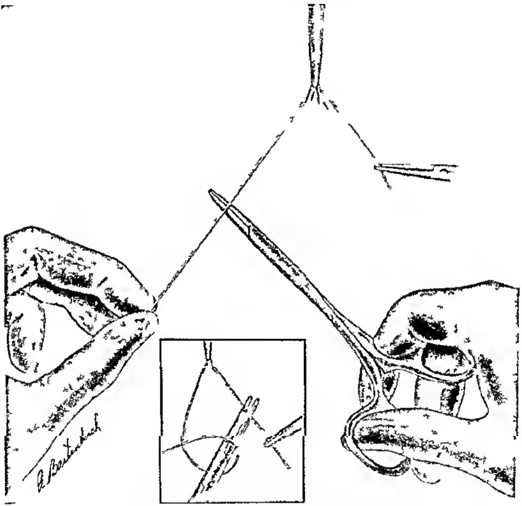

FIG 19 Tying a short end by an artery forceps (second turn)

usually employed when blood vessels are situated in a mass of other tissues and when it is either impossible to separate the vessels, or when it is a time-consuming procedure, and when at the same time the mass is too large to permit an ordinary method of applying the ligature on account of the danger of slipping They are usually applied to the stump of the omentum, to the infundibulopelvic ligament, to the broad ligament, and so forth There are several methods of placing them

Method 1.

With the threaded needle the middle of the stump is pierced and that portion of the stump lying to the right (or to the left) of the hole made by

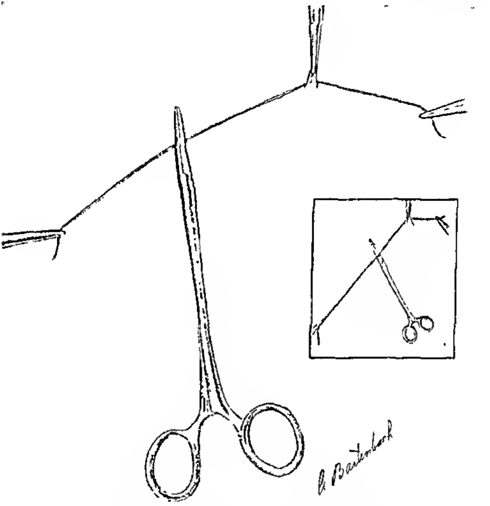

FIG. 20. Tying a ligature by a "no hand touch technic."
Insert. Second turn of a square knot.

the needle is ligated (Fig. 24, a); then both ends of the thread are carried around the entire stump and tied (Fig. 24, b).

Method 2.

A mattress-suture is inserted in the middle third of the stump; the ends are then carried around the entire stump and tied (Fig. 24, c).

Method 3.

Figure-of-8 Transfixion Suture (Fig. 25, a, b).

Method 4

The Doyen Method of Ligating by Circular Ligation and Transfixion (Fig 25 c, d, e)

In the aforementioned methods, the stump situated distally to the ligature is entirely deprived of blood supply As a result, this stump will

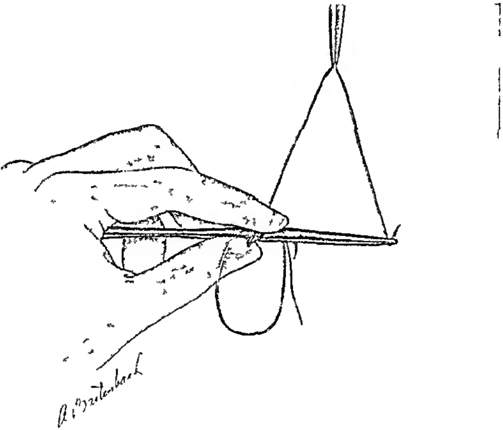

Fig 21 Tying a thread on one end of which is a curved needle and on the other end an artery forceps (first turn)

become the seat of a dry or white infarct, and this will in course of time, either become absorbed or be encapsulated as an aseptic foreign body

However, there are other methods of applying a transfixion ligature which do not shut off the blood supply completely It is true that no actual bleeding occurs distal to the ligature immediately after ligation and cutting of the stump, the surgeon believes the ligature to be completely hemostatic,

however, a little later collateral circulation is established through the part not caught in the ligature; a red infarct is formed in this distal stump with possible future infection and the formation of adhesions.

The first group of ligatures which *completely shut off the blood-supply*

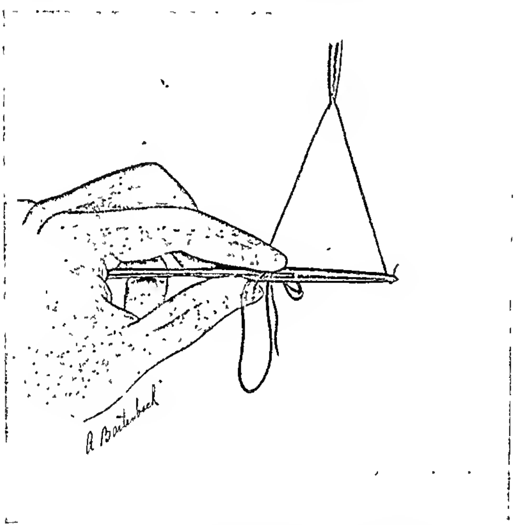

FIG. 22. Tying a thread on one end of which is a curved needle and on the other end an artery-forceps (second turn).

are known as occluding ligatures, and the second type are known as *sub-occluding ligatures*. Below are given a few examples of sub-occluding ligatures which never should be employed:

1. A transfixing ligature through the stump leaving part of the stump free; the ligature will not slip but it will be a sub-occluded ligature (Fig. 26, a).

2. Another type of sub-occuluded ligature (Fig. 26, b). This however can be transformed into a "chain ligature."

3. Another type of unsatisfactory transfixed ligature: A hole in the stump may be formed at point A, due to the pulling of the two threads laterally; bleeding may start from this point (Fig. 26, c).

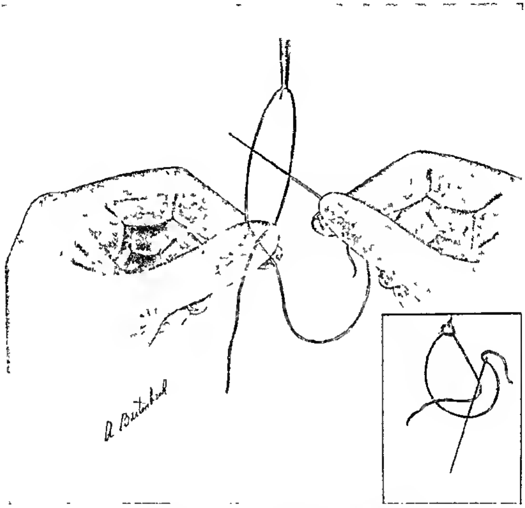

FIG 23 Oviatt method of tying a knot (seamstress knot).

DIFFERENT METHODS OF SUTURING THE ABDOMINAL WALL

Suture of the abdominal wall as a routine operative procedure was introduced much later than suture of the abdominal viscera. The number of methods of suturing the abdominal wall is far less than those of suturing the abdominal viscera, and they are in the majority of cases methods which were already used for suturing the abdominal viscera, especially the in-

testines. In former days, when surgeons preferred to use non-absorbable material for deep sutures, which were to be removed, many methods were devised for the easy removal of these sutures. Now we very seldom use deep non-absorbable sutures as removable sutures. Another cause of the

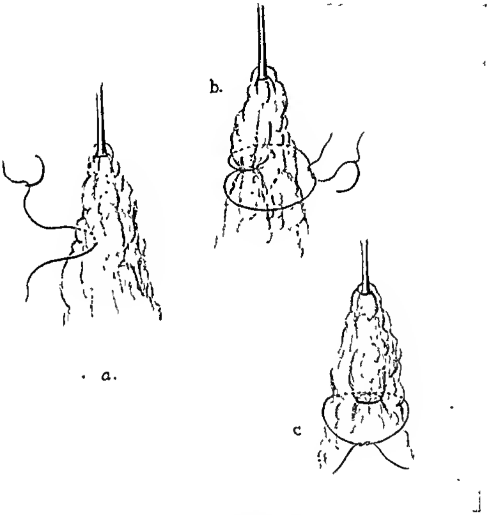

Fig. 24. Occluding ligatures.

large number of different methods of suturing in previous years was the desire to suture simultaneously the different layers of the abdominal wall. Now these methods are replaced by the much simpler methods of layer suturing.

1. Simple Interrupted Suture (Button-hole Suture) (Fig. 27, a).

This is used for closure of the different layers, namely, peritoneum, muscles, fascia, skin. The advantage of this type of suturing is that each

suture is tied separately and therefore breaking or removal of one stitch does not weaken the entire length of the suture line. Another advantage is that in case of an irregular skin incision it closes the wound more neatly.

The disadvantages of interrupted sutures are that they require more

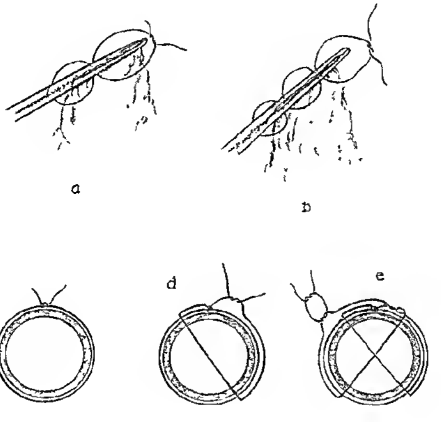

FIG 25 Occluding ligatures a and b Figure-of-8 transfixion suture c, d, e Circular ligation and transfixion suture of Doyen

time for their insertion, and that many knots are made. For all layers with the exception of the skin, it is more convenient to use a curved needle on a needle-holder. For the skin it is more convenient to use a straight needle with a sharp, cutting point. When using a straight needle, a needle-holder is not required. When working with a curved needle on a needle-holder, it is always more convenient to start from the distal lip, and then take a bite on the proximal lip, and from the part of the wound most remote from the

surgeon to the part of the wound closer to him. In working with the straight needle the reverse is true; it is more convenient to catch first the lip proximal to the surgeon and then the distal lip, and from the point closest to the surgeon to the point farthest from him.

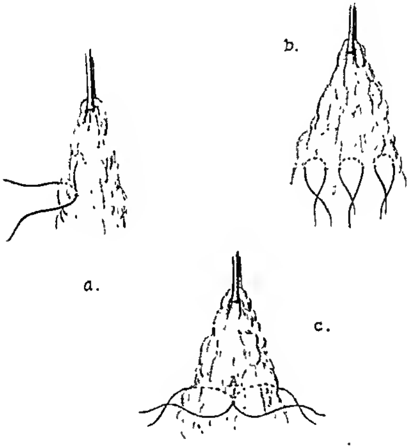

FIG. 26. Sub-occluding ligatures.

2. Continuous Over-and-over Suture (Glover Suture) (Fig. 27, b).

This is used as the previous one. Its advantage is that it can be placed more quickly; its disadvantage is, that in case of suppuration or exploration, when it is necessary to remove one suture, the entire suture line is broken.

In order to tie the last stitch, the free end of the thread is made much longer than the other end. When the needle takes the last bite, then on one side of the wound remains the free end of the thread and on the other the

needle with a double thread (Fig. 27, c). The free end is now tied to the double thread on the other side of the wound.

3. **Continuous Button-hole Suture** (Fig. 28).

A straight needle is used and the suturing starts from the left side and

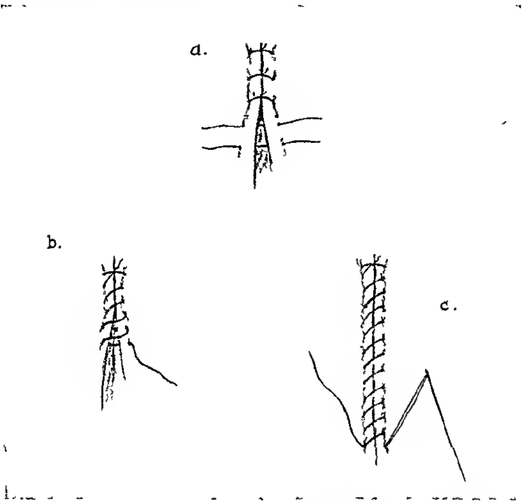

Fig 27. a Buttonhole suture, b. Glover suture, c. Glover suture—inserting the last stitch.

extends to the right. The lip proximal to the surgeon is first pierced and then that distal to the surgeon, thus making an ordinary button-hole stitch, which is tied by a reef or a granny knot. The thread is held in the left hand, and the needle, held in the right hand, is carried in front of the thread, thus forming a loop through which the needle passes. The last suture is inserted in a reverse direction, thus maintaining the button-hole sutures throughout (Maunsell method) (Fig. 28, insert). This suture nicely approximates the skin edges, but is not a strong one. For this reason it can be used only

in those cases in which either tension sutures are used or in which the subcutaneous tissues are sutured before the closure of the skin.

4. **Double-lock Button-hole Suture** (*Fig. 29, a*).

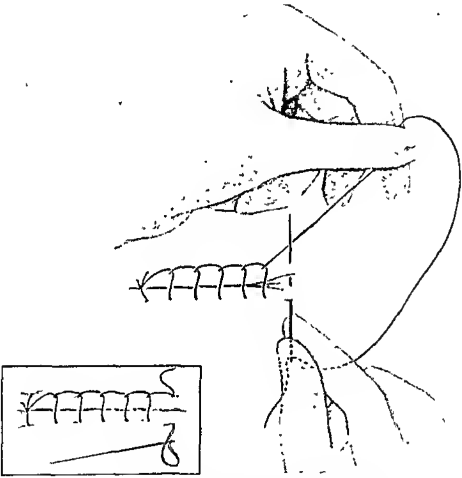

FIG. 28. Continuous button-hole suture.
Insert. Maunsell method of inserting the last stitch.

This has some advantages over an ordinary button-hole suture, in that each link of the chain is less liable to loosen in case one link is cut.

5. *Figure-of-8 Suture* (*Fig. 29, b*).

Including the skin, fascia and anterior sheath of the rectus muscle only. This type of suture was frequently used during the time when the non-absorbable suture was employed not only for suturing the skin, but also the deep layers of the abdominal wall, the surgeon intending later to remove it. But when absorbable suture-material replaced the non-absorbable

in suturing the deep layers of the abdominal wall, the employment of this type of suture became infrequent.

6. Figure-of-8 Interrupted and Continuous Suture for Skin and Superficial Fascia only (Fig. 29, c, d).

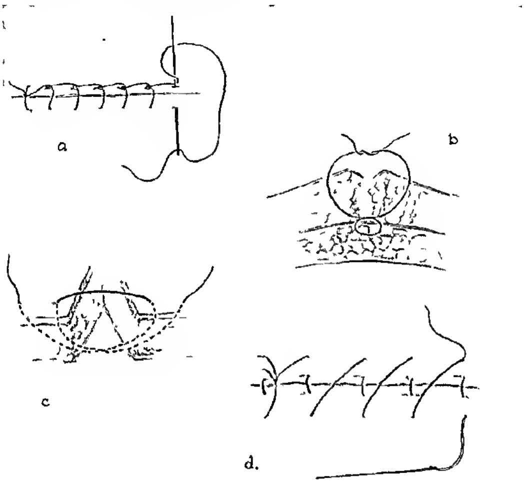

FIG 29 (after Printy) a Double-lock continuous button-hole suture b Figure-of-8 suture for skin, fascia and anterior sheath of rectus muscle c Figure-of-8 suture for skin and fascia only. d Continuous Figure-of-8 suture.

7. Horizontal Mattress Suture, Interrupted (Fig. 30, a).

Thus suture was described by the Italian surgeon Lanfranch about the year 1300, and was used for closure of the abdominal wall. The Continuous Horizontal Mattress Suture was introduced in the XVIIIth Century by Sabatier and Richerand; it was known under the name of *sutura transgressiva* and it was used up to the middle of the XIX century; it is now obsolete.

8. Vertical Mattress Suture (Fig. 30, b, c).

This suture was first described by R. M. McMillen in 1909. The same suture is known under the names of different men, who described it later, evidently being unaware of McMillen's publication. This suture is made in the following manner: A needle penetrates one cutaneous lip at a distance

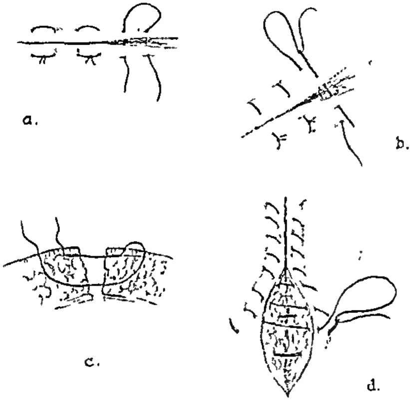

FIG. 30. Mattress sutures. a *Horizontal mattress-suture.* b and c. *Vertical mattress-sutures.* d. *White method of continuous vertical mattress-suture.*

of half an inch from its edge from without inward, then the other lip from within outward also at a distance of half an inch from its edge; the needle is then reversed and penetrates the second cutaneous lip at its very edge and then the first lip at its edge. The ends of the suture are then tied.

This is an excellent suture: the edges of the skin are closely approximated, so that the resulting scar is hardly noticeable. The lips are approximated by broad raw surfaces and for this reason a strong union takes place. The deep limb of the suture acts as a tension-suture.

9 Superficial and Deep Continuous Suture [Continuous Vertical Mattress-suture (White Method)] (Fig 30, d)

A button hole suture is made and tied, then a deep suture, including the entire thickness of the skin, is carried from one lip of the incision to the opposite, about half an inch from the edge The needle is then reversed and the suture passed obliquely toward the other side (or the side on which the suture was started) barely engaging the edges of the lips The needle is then introduced a little lower, on the side on which it originally entered, half an inch from the edge, and the first deep suture is repeated These deep and superficial sutures are repeated until the wound is closed This suture is simple and speedy in execution, the edges are very closely approximated, so that the resulting scar will be hardly noticeable The wide, opposing raw surfaces give a firm union This suture eliminates the dead spaces, which in itself is conducive to primary union of the wound

For closure of the skin, in our work, we usually use a vertical mattress suture as described under number 8 (Fig 30, b, c) or Michel clips

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CHAPTER II

ABDOMINAL INCISIONS

In making a proper abdominal incision, several prerequisites are necessary

1 A good operative field should be afforded by a properly made incision

2 Physiologico-anatomical Considerations

The incisions should be performed in such a manner as to mutilate the abdominal wall as little as possible

3 Cosmetic Considerations

The incisions should be made in such direction that they will leave no large and deforming scars

4 Psychological Considerations

1 That the incision should be made so as to give a good operative field does not require much discussion Indeed, the recognition of the necessity for a good operative field was one of the most important factors in the development of surgery, and in its importance it stands next to the introduction of anesthesia and antiseptic and, later, aseptic technic in surgery A good operative field results not only from a properly made incision but also from the judicious use of retractors, forceps, a proper posture of the patient (as in kidney operations), and a proper elevation of the parts of the body (as in gall bladder operations)

2 Next in importance to the necessity of a good operative field is the infliction of as little damage as possible to the abdominal wall Before discussing this in detail, a brief review of the anatomy of the abdominal wall will be of value

Anteriorly, the abdominal wall consists of the following layers

Skin

Examination with a magnifying glass shows quite clearly that numerous fissures cross the skin in a transverse, slightly semicircular direction They were described by Langer in 1861, and they are known as the "fissure lines of Langer" (Fig 31, a, b) Kocher emphasized the surgical significance of these fissures, and showed that the healing of skin wounds is much neater when the incisions are made along them, he advocated making such incisions, and these, therefore, are known as the "normal incisions of Kocher" (Fig 31, a, b)

Superficial Fascia.

This is a layer which is continuous with the superficial layer of the adjoining parts of the body; at a level approximately midway between the umbilicus and symphysis pubis it splits into two layers:

Superficial layer of the superficial fascia (Camper's fascia);

Deep layer of the superficial fascia (Scarpa's fascia).

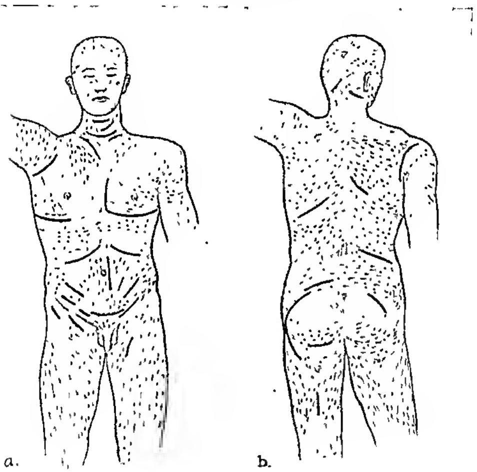

FIG. 31. Fissure-lines of Langer. Normal incisions of Kocher (after Kocher). a. Anterior view. b. Posterior view.

The superficial layer of the superficial fascia (Camper's fascia) passes downward over the inguinal ligament and becomes directly continuous with the superficial fascia of the front of the thigh.

The deep layer of the superficial fascia (Scarpa's fascia) is carried

downwards over the spermatic cord, the penis and scrotum, into the perineum, where it becomes continuous with Colles' fascia In the region of the groin, the Scarpa's fascia is attached to the fascia lata just a little distal to the inguinal ligament This line of attachment is known as Holden's line

The surgical significance of this arrangement is that extravasation of urine from the urethra, ruptured below the urogenital diaphragm, will flow into the scrotum, then over the penis and along the spermatic cord into the anterior abdominal wall From the abdominal wall it cannot pass downward to the front of the thighs, because Scarpa's fascia is firmly attached to the fascia lata of the thigh

Deep Fascia

This layer lies behind the superficial fascia It is not always equally well developed

Muscles

Posterior to the deep fascia on both sides of the middle line are situated the rectus abdominis muscles, right and left, and the pyramidalis muscles (the latter being absent in 16 to 25 per cent of the cases) The direction of their fibers is parallel to the long axis of the body (Fig 32) On the lateral side of the anterior wall, the muscles are arranged quite differently They consist here of three layers, external oblique, internal oblique and transversus abdominis muscles The direction of the fibers of these muscles is such that they cross each other at different angles in some places at acute angles, in some places nearly perpendicularly, and in other places at obtuse angles The exact knowledge of the direction of the fibers and their mutual relationship is of great importance in making a proper abdominal incision

The external oblique muscle is a broad flat structure It takes its origin from the lateral surfaces of the fifth to the twelfth ribs by eight slips The five upper slips interdigitate with the slips of the anterior serratus muscle and the lower three slips with the latissimus dorsi muscle These slips join each other and form a thin, flat muscle the fibers of which run downward, inward and forward The fibers of this muscle do not run everywhere in the same direction, the obliquity increases from before backward, so that in the posterior part of the muscle the fibers run nearly vertically downward (Fig 42) The entire muscle, with the exception of the lower posterior portion, ends in a broad aponeurosis This aponeurosis which is nothing but the flattened tendon of the muscle, starts along the entire length of the medial edge of the external oblique muscle, where it helps to form the anterior sheath of the rectus muscle, and also along an imaginary line drawn between the anterior superior iliac spine and the

umbilicus. It runs downward, inward and forward and extends between the anterior superior iliac spine and the spine and crest of the pubic bone, forming Poupart's ligament (inguinal ligament) (Fig. 32). It is very important to remember this arrangement, because in cases in which the

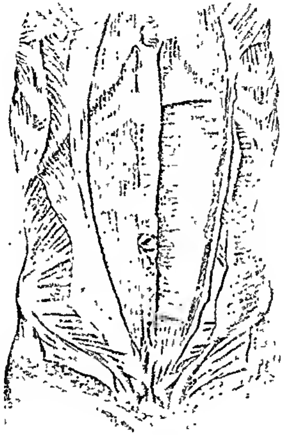

FIG. 32. Muscles of the anterior abdominal wall (after Cunningham).

surgeon operates in the region below the imaginary line connecting the anterior superior iliac spine and the umbilicus, the first muscle encountered will be the *internal oblique* and *not* the *external*, which in this region is already aponeurotic. The posterior fibers are attached to the anterior half of the outer lip of the crest of the iliac bone.

The internal oblique muscle is thin and fan-shaped (Fig. 32). It arises from the lumbo-dorsal fascia, the anterior two-thirds of the intermediate

lip of the iliac crest, and from the lateral half of Poupart's ligament The fibers of this muscle run in different directions, forming a wide fan, its posterior fibers run upward and slightly forward and are directly attached to the outer surface of the 10th, 11th, and 12th ribs, the rest of the fibers extend to the lateral border of the rectus muscle and become aponeurotic, this aponeurosis immediately splits into two layers (lamellae), the anterior

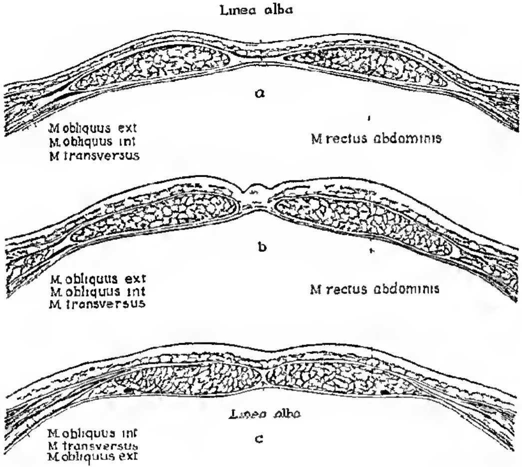

Fig 33 Formation of the sheaths of the recti abdominis muscles (after Rauber)

lamella fuses with the aponeurosis of the external oblique muscle and forms the anterior sheath of the rectus muscle The posterior lamella fuses with the aponeurosis of the transverse abdominis muscle and forms the posterior sheath of the rectus muscle (Fig 33) [The line along which the transversus abdominis muscle becomes aponeurotic is known as the linea semilunaris (linea Spigelii in the O T)] This arrangement of the sheath

of the rectus muscle persists throughout the length of the muscle with the exception of the uppermost and lowermost portions where the posterior sheath is deficient. In the upper portion it is deficient in that part of the muscle which rests on the chest-wall, and in the lower portion it is deficient beginning approximately from the point midway between the umbilicus and the symphysis pubis.

Beginning at this level, the posterior lamella of the aponeurosis of the internal oblique muscle and the aponeurosis of the transversus abdominis muscle fuse with the anterior lamella of the internal oblique muscle and with the aponeurosis of the external oblique to form the anterior sheath of the rectus muscle. This difference in thickness of the posterior sheath in the upper part and lower quarter of the muscle is clearly shown at the place where their border forms a thickened semi-arcuate line, which is known as the **linea semicircularis** (B. N.) or **semilunar fold of Douglas** (O. T.) (Fig. 32).

The transversus abdominis muscle (Fig. 32) arises:

a. From the posterior surfaces of the cartilages of VII, VIII, IX, X, and the posterior surfaces of the XI and XII ribs by six slips. These interdigitate with the slips of origin of the diaphragm.

b. From the lumbo-dorsal fascia.

c. From the anterior two-thirds of the internal lip of the iliac crest; and

d. From the lateral third of the inguinal ligament.

The muscular fibers run mostly horizontally perpendicularly to the midline of the body. The muscle ends in an aponeurosis which participates in the formation of the posterior sheath in the upper three-fourths of the rectus muscle, and in the lower fourth it participates in the formation of the anterior sheath of the rectus muscle. Thus, the aponeurosis of this muscle participates in the formation of the linea alba in its entire length.

The lowest part of the aponeurosis of the transversus abdominis muscle fuses with the aponeurosis of the internal oblique and forms the **falx inguinalis** (B. N.) (**conjoined tendon** O.T.), which is attached to the anterior surface of the pubic bone and to the ilio-pectineal line.

The next structure lying behind the above mentioned muscles is the **transversalis fascia**. This is a continuous layer which surrounds the entire abdominal cavity external to the peritoneum. It is known by different names in different regions, being at the same time one continuous layer. Thus, in the anterior abdominal wall it is known as the **transversalis fascia**; in the upper part, where it serves as a lining for the diaphragm, it is known as the **diaphragmatic fascia**; in the fossa iliaca as the **iliac fascia**; in front of the psoas and quadratus lumborum muscles as the **lumbar fascia**; and on the pelvic floor as the **pelvic fascia**. This layer is very

important because it is strongly elastic and, according to modern views, it prevents the formation of hernia more than any other single factor. Its fibers are circular and always perpendicular to the longitudinal axis of the body (Fig. 34).

The next layer is the peritoneum; however, between the transversalis

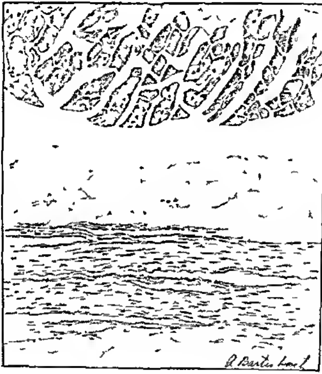

FIG 34 Cross section of the anterior abdominal wall The fibers of the transversalis fascia are running perpendicularly to the midline

fascia and peritoneum there is accumulated a definite amount of fat; this fat in some places accumulates in larger quantities (as around the kidneys, suprarenal glands, abdominal aorta, etc.).

The surgical significance of it is that occasionally it misleads an inexperienced operator; after cutting the transversalis fascia he thinks that he is already in the abdominal cavity; he begins to dig into the fat

trying to orientate himself instead of going boldly through the fat and the peritoneum and entering the abdominal cavity.

In the midline of the body is found the linea alba, *which is composed* of the fused anterior and posterior sheaths of the recti muscles. This line is not of equal width; in the upper part it is approximately 1 to 2.5 cm. wide and in the lower 1.4 to 1.8 cm.

Let us recapitulate the most important features of the arrangement of the anterior abdominal wall in connection with the future discussion of the anterior abdominal incisions.

The linea alba (Figs. 32, 33), which extends between the ensiform process and the symphysis pubis, consists of numerous fibers which are a continuation of the anterior and posterior sheaths of the recti muscles; the direction of these fibers is horizontal, and when making a midline incision they are cut transversely, perpendicular to the direction of their fibers. The anterior sheath of the rectus muscle is not a fascia; it is an *aponeurosis*, i.e. a flattened *tendon, formed by a fusion of the* aponeurosis of the external oblique muscle with the anterior lamella of the aponeurosis of the internal oblique muscle; its fibers run perpendicularly or obliquely to the long axis of the body, and when incising the anterior sheath of the rectus muscle longitudinally we actually cut transversely the terminal parts of the external oblique muscle and of the anterior lamella of the internal oblique muscle.

Rectus abdominis muscle.

The fibers run *longitudinally, and splitting of the fibers gives* free access to the abdominal cavity. However, the accompanying injury to the nerves makes muscle-splitting of the rectus not a desirable feature.

The oblique muscles of the lateral abdominal wall (external and internal oblique muscles and transversus abdominis muscle) have their fibers running in different directions; for this reason the fibers of the entire thickness of the wall cannot be split in one direction. The external oblique muscle can be split only in a downward, inward and forward direction, and only after the split parts are retracted can the internal oblique muscle be split according to its location:

a. In the upper part of the lateral abdominal wall, in an upward, inward and forward direction.

b. In the middle part of the lateral abdominal wall, in an inward and forward direction; and

c. In the lower part of the lateral abdominal wall, in a downward, inward and forward direction.

The transversus abdominis muscle can be split after the split lips of the external and internal oblique muscles are retracted; they can be split in an inward direction.

The transversalis fascia can be split only in a direction perpendicular to the midline; incision in any other direction will cut its fibers

The peritoneum can be split in a transverse direction only; incision in any other direction will cut the fibers

The blood-supply of the anterior abdominal wall is derived from the following arteries (Fig 35)

Superior epigastric,
Tenth and eleventh intercostal,
Subcostal,
All the lumbar arteries (4 or 5 in number),
Inferior epigastric,
Deep circumflex iliac,
Superficial epigastric,
Superficial circumflex iliac, and
Some branches of the external pudendal artery

The nerve-supply of the anterior abdominal wall (Fig 35) is derived from the 7th, 8th, 9th, 10th, 11th, and 12th thoracic nerves, and from the ilio hypogastric and ilio-inguinal branches of the first lumbar nerve

It we will analyze the course of the fibers of the recti muscles and the direction of the blood-vessels and nerves, we will notice that the main blood-vessels (superior and inferior epigastric arteries) run in the same direction as the fibers of the muscles, and that the intercostal arteries run in a direction perpendicular to these fibers The nerves run perpendicularly to the fibers of the recti muscle This means that in opening the abdomen by splitting the fibers of the rectus muscle, we preserve part of the blood-supply (superior and inferior epigastric arteries) and we sacrifice another part of it (abdominal termination of the lower intercostal arteries), and also the fibers of the sheaths By opening the abdomen through a transverse incision we sacrifice the superior (or inferior) epigastric artery, but preserve the abdominal terminations of the lower intercostal arteries and also the fibers of the sheaths In either case there will be enough blood-supply left to take care of the nutrition of the abdominal wall

However, with the nerve supply things are different In the case of the longitudinal, muscle splitting incision, we preserve the muscle and cut the nerve-supply The number of severed nerves depends on the length of the incision In the case of a longitudinal incision between the ensiform process and the umbilicus, at least three nerves will be sacrificed In making a longitudinal incision, the farther we go from the median line the more muscle is left without innervation and the more damage is done to the muscles lying to the inner side of the incision By cutting the rectus muscle transversely, we preserve the nerve supply

By making an incision in the anterior abdominal wall lateral to the

recti muscles, there is only one way to preserve both the muscles and the nerves, namely, to make a muscle-splitting incision with retraction of the nerves which lie on the transversus abdominis muscle.

The earliest types of abdominal incision were longitudinal. However, in many of these cases post-operative ventral hernias followed. At first it

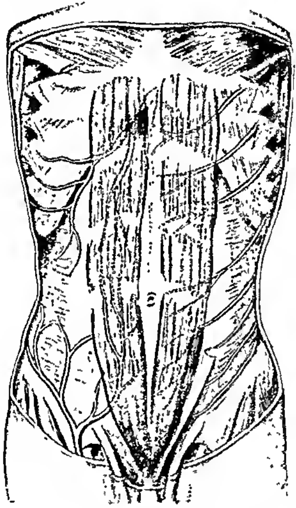

FIG. 35 Blood-supply and nerve distribution of the anterior abdominal wall.

was thought that this was due to frequent suppuration of the wound, to the use of an unsuitable suture-material (some blamed the use of soluble material, some of insoluble), to the method of suturing, some considering that each layer should be sutured separately while others believed that the layers should be sutured together, devising for this purpose the figure-of-eight suture. Some considered that the deep fascia should be carefully sutured, etc. However, in many cases in which no suppuration ensued,

where either soluble or insoluble suture material was used, where the abdomen was sutured either through its entire thickness, or through several layers, or separately through each layer, in a definite number of cases ventral hernia followed the operation sooner or later In some of the cases the discomfort produced by the post-operative ventral hernia was greater than the discomfort due to the disease which called for the abdominal operation The inability of the surgeons to prevent the formation of post-operative hernia irrespective of the type of suture-material and the method of closing the abdomen, led some investigators to believe that the cause of post-operative ventral hernia lies in the making of improper incisions

In 1898, P Assmy, of Czerny's Heidelberg clinic, carried out, at the suggestion of Czerny, several experiments making longitudinal abdominal incisions in which several nerves were cut, and transverse incisions in which the nerves were preserved He was able to demonstrate that in the case of the longitudinal incisions the part of the muscle lying to the inner side of the incision became atrophied, whereas the part lying laterally remained normal The scar that was formed was attached laterally to normal muscle and medially to atrophied muscle Sprengel, in 1912, emphasized the fact that in cutting the anterior sheath longitudinally the operator actually severed the aponeurotic continuation of the lateral abdominal muscles (See Anatomy of the Anterior Abdominal Wall), and for this reason the scar sooner or later became wider, thinner and weaker, and if this reached a definite degree, the scar gave way and a ventral hernia ensued

After the work of Assmy many surgeons started to use transverse incisions However, it should be remembered that transverse incisions were made by some surgeons before the work of Assmy Billroth, when he performed his first gastrectomy in 1881, used a transverse incision However, these surgeons did this not because of less injury to the nerve-supply but because they considered that such an incision gives better exposure and more convenient drainage It is used far less frequently than the longitudinal incision, nevertheless, it has been used in such a great number of cases that definite conclusions can be made, and its advantages are quite evident

1 It is followed far less frequently by post-operative ventral hernia, or by an acute disruption of the wound,

2 The closure of the abdomen is easier because the approximation of the edges is easier and it is not necessary to "fight" with protruding bowels,

3 Due to less tension the patient is not afraid to cough, and for this reason cases of post operative pneumonia are far less frequent,

4 The time of confinement to bed is shorter,

5. The scar is less visible, and thus cosmetic results are obtained.

It seems to us that transverse incision, not only of the skin but also of the entire thickness of the abdominal wall, will become more and more the choice in the future.

The numerous incisions which have been described may be subdivided into three large categories:

A. Transverse and gridiron incisions;
B. Longitudinal incisions;
C. Flap incisions.

A. TRANSVERSE INCISIONS

These are characterized by a transverse cutting of the abdominal wall, observing the following prerequisites:

1. The skin is cut along the "fissures of Langer";
2. The anterior sheath is cut perpendicularly to the midline;
3. The muscle is either retracted or cut transversely;
4. The posterior sheath, transversalis fascia, and peritoneum are cut transversely; there is then no injury to the nerves;
5. The blood-vessels should be spared as much as possible, but, as mentioned above, the arrangement of these vessels is such that some of them have to be sacrificed no matter how the incision is made.

1. Mikulicz-Kausch Incision. Suggested in 1900. (Fig. 36[1]).

This runs from the lower part of the right costal arch medially and slightly downward until it reaches the midline. It cuts transversely all the structures of the abdominal wall—skin, fascia, anterior sheath of the right rectus muscle, right rectus muscle, posterior sheath of the right rectus muscle, transversalis fascia and peritoneum. It does not injure the nerves, leaves enough blood-supply, and cuts the anterior sheath and posterior sheath of the rectus muscle along the course of its fibers. It is useful for gall-bladder operations, and for work on the pylorus, duodenum and biliary ducts.

2. Sprengel Incision (Fig. 36[2]).

This incision consists of two limbs, made at right angles to each other; the short one running obliquely downward and inward until it reaches the lateral border of the rectus muscle; the inner one crossing the rectus muscle in a medial and slightly upward direction. The shorter limb cuts through the skin, superficial and deep fascia, and splits the fibers of the external oblique muscle, not going any deeper; the medial limb cuts transversely the rectus muscle and its posterior sheath, the transversalis fascia and the peritoneum—all in a transverse direction. Essentially, it is the same as the Mikulicz-Kausch incision, with additional space for work in case of stout patients. It is used for work on the gall-bladder, biliary ducts,

duodenum and pylorus. The same type of incision, made only on the left side, is suitable for all work on the stomach, spleen, splenic flexure of the colon, and the transverse colon.

3. Courvoisier Incision (Fig. 36[3]).

This runs from the lower border of the right costal arch medially and

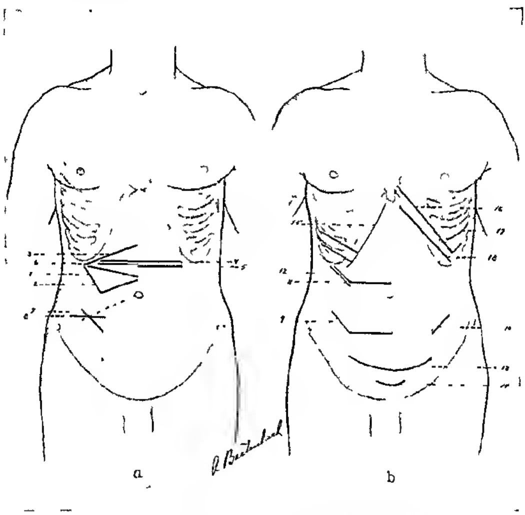

Fig 36 a and b Different transverse and oblique incisions

slightly upward until it reaches the midline. In technic of execution, in the merits of the incision, and in the indications for the kind of operations for which it is suitable, it is analogous to the Mikulicz-Kausch incision.

4. Bilateral Transrectus Transverse Incision (Fig 36[4]).

This consists of a transverse incision from the right border of the right rectus muscle to the left border of the left rectus muscle. It cuts through all the structures transversely. After the peritoneum is opened,

the falciform ligament is cut between two ligatures. It gives an excellent operative field for work on the stomach. For cases of total gastrectomy it is the best of all "purely abdominal" incisions. It is also excellent for all ordinary work on the stomach, duodenum, bile-ducts, and pancreas.

5. Left Transverse Rectus Incision (Fig. 36[5]).

This incision extends transversely through all the structures from the left margin of the left rectus muscle to the midline. It cuts all the structures transversely, and is suitable for gastro-enterostomy and gastrostomy operations.

6. Right Transverse Rectus Incision (Fig. 36[6]).

The technic is the same as on the left side. It is suitable for some cases of gall-bladder work, and for work on the duodenum and the pyloric end of the stomach.

7. McBurney Incision (Fig. 36[7]).

The incision was suggested by Charles McBurney, of New York, in 1894. The incision crosses a point which lies one inch medial from the anterior superior iliac spine on an imaginary line drawn between this spine and the umbilicus. From this point a line is made perpendicular to the above mentioned line for a distance of two and a-half to four inches; one-third of the incision is situated above this line and two-thirds below. It is a muscle-splitting incision, which does not cut either the muscles or the blood-supply or nerve-supply. The details of the technic will be given below. This incision, although it does not exactly follow the cosmetic requirements, nevertheless is ideal in a physiological sense because it does not injure either the nerves or the muscles, and when correctly made is not followed by post-operative hernia. It is indicated for appendectomy, appendicostomy, cecostomy, and, in suitable cases, even resection of the cecum is possible.

8. Rockey Incision (Fig. 36[8]).

A transverse incision of one and one-half inches is made, starting from the McBurney point as its center. The skin, superficial and deep fascia are cut, so that the aponeurosis of the external oblique muscle is exposed. The rest of the operation is exactly as in the McBurney "gridiron" incision.

Indication. The same as in the McBurney incision. This operation was suggested by Rockey, in 1905, In Germany, it is known as the Sonnenburg incision, and in this country it is also known as the Davis incision. Davis suggested it in October, 1905. Although Rockey advocated using a very small incision (1½ inches), we believe that the skin-incision should be larger (2½ inches). This incision satisfies not only the anatomico-physiological, but also the cosmetic requirements.

9. Harrington Incision (Fowler Incision, "Weir Extension Incision") (Fig. 36[9]).

This incision was described by F B Harrington in August, 1899, by Weir in February, 1900, and by Fowler in March, 1900

In Germany, it is known as the Winkelmann incision However, Winkelmann did not speak of this incision until 1909, and does not claim originality

The initial part of this incision is the McBurney "gridiron" incision When during the course of operation, it becomes evident, that some other work, not contemplated before, is required, and that the "gridiron" incision does not offer enough room, the incision is extended in the following way The rectus muscle is retracted medially, and the posterior sheath and peritoneum are cut transversely up to the midline This incision enables the surgeon to work on the appendix, when it is directed medially into the pelvis, and particularly when it is bound down by adhesions, and also on the ovary and the tube on the right side

10 Left "Gridiron" Incision (Fig 36^{10})

The landmarks and technic of execution are exactly the same as for appendectomy, with the difference only that it is done on the left side It is used for left inguinal colostomy

11 **Right Upper "Gridiron" Incision** (Fig 36^{11})

The technic is exactly the same as in the McBurney incision, the difference is only in locality The indication is cholecystostomy However, if in the course of the operation it becomes evident that there is not sufficient room, whether because a cholecystectomy is necessary, or work on the stomach or on the biliary passages, then the incision may be enlarged by transforming it into a

12 Right Upper "Gridiron" Incision, with a transverse incision of the posterior sheath of the right rectus muscle up to the midline (Fig 36^{12})

In this way, it becomes a "right upper Harrington incision"

13 Pfannenstiel Incision (Fig 36^{13})

Suggested in 1898 and published in 1900

The skin, superficial and deep fascia are cut transversely (in a slightly semicircular line) The anterior sheath of the rectus muscle is cut transversely The recti muscles are retracted from each other The transversalis fascia and peritoneum are cut longitudinally

This incision is not strictly physiological, however, because in the lower quarter of the abdomen the aponeurosis of the internal oblique and transversus abdominis muscles participates in the formation of the anterior sheath only, the damage caused by this longitudinal incision is confined to the transversalis fascia and peritoneum only For this reason it is less *than if the arrangement of the aponeurosis in this lower quarter was the* same as in the other parts of the abdomen It is of interest to note, that this incision, introduced by a gynecologist for gynecological operations,

was the forerunner of all physiological incisions which were suggested later and introduced in general abdominal surgery. It is worth mentioning, that arguments were raised by several contemporaries of Pfannenstiel as to whom the priority of the incision belonged. This may be settled by stating that as long ago as 1789, Dr. John Hull in his "A Defense of the Cæsarean Operation with Observations on Embryulcia, and the Section of the Symphysis Pubis," published in Manchester, England, in 1789, advocated the use of a transverse incision for Cesarean section.

14. Küstner Incision. Suggested in 1896 (Fig. 36[14]).

This is a transverse, slightly semicircular incision at the margin of or within the pubic hair, and extends through the skin only; all the deeper structures are cut longitudinally through a midline incision. As may be seen, this incision is actually a midline longitudinal incision. It fulfils only cosmetic requirements, because it cuts the skin along the fissure lines of Langer. However, it violates the anatomico-physiological requirements. It is of interest to know, that this incision influenced Pfannenstiel to use his incision, which is considered as a forerunner of all contemporary transverse incisions.

A few other physiological incisions, made by abdomino-thoracic approach (both extrapleural and transpleural) and by lumbar approach, will be given under corresponding headings.

B. LONGITUDINAL INCISIONS

1. Midline Incision (Fig. 37[1]).

This is the oldest type of incision. It may be made either in the epigastric, umbilical or hypogastric regions. The incision has great advantages. The abdomen can be quickly opened and closed; it gives a good view of the entire abdomen, and for this reason it is excellent for exploratory purposes. From the standpoint of a good operative field, it is a very excellent incision, because nearly 80 per cent of all abdominal work can be done through a midline incision. The objectionable feature of the incision is that it cuts the linea alba, i.e. the terminal fibers of the aponeurosis of all lateral muscles, perpendicular to their course, and for this reason, under the influence of traction by lateral abdominal muscles, the scar yields, producing a ventral hernia. Another objectionable point is that the linea alba has a very poor blood-supply, and for this reason is not capable of forming a strong scar.

2. Paramedian Incision (Right or Left) (Fig. 37[2]).

This was first described by Hagen-Thorn, in 1884.

It consists of a longitudinal incision through the anterior sheath of the rectus muscle, followed by retraction of this muscle and incision through the posterior sheath of the muscle immediately lateral to the linea alba. The rectus muscle thus lies between the weakened points in

the posterior and anterior sheaths and, therefore, diminishes the possibility of hernia However, the objectionable feature of this incision is that it divides the anterior and posterior sheaths longitudinally, i e in a direction perpendicular to their fibers In case it is desired to open the abdomen by

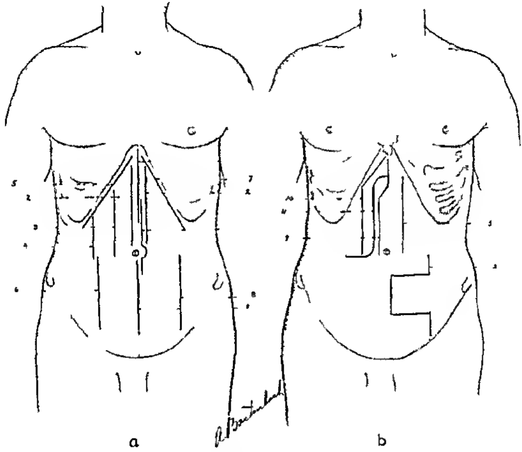

FIG 37 a and b Different longitudinal and some oblique and flap incisions

a longitudinal incision, this should be given preference to a midline incision

3 Right Midrectus Incision (Riedel Incision) (Fig 37[3])

This runs longitudinally midway in the right rectus muscle from the costal arch to the level of the umbilicus The skin, fascia and anterior sheath of the rectus muscle are incised, the rectus muscle is split longitudinally, and the posterior sheath and peritoneum are divided longitudinally This incision gives a *good operative exposure*, but *it cuts the sheaths*

in a non-physiological manner, and also severs at least three intercostal nerves, thereby producing an atrophy of that part of the rectus muscle which is situated medially to the line of the incision. Altogether, we do not recommend this incision on the right side at all, while on the left it *may be used occasionally for gastrostomy operations* (Fig. 37[13]).

4. **Right Upper Pararectus Incision (Fig. 37[4]).**

This is used for gall-bladder work.

In Germany, it is known as the **Langenbuch incision**, in English speaking countries, as the **Lawson Tait incision**. It runs along the lateral border of the right rectus muscle. It starts at the point where the lateral border of this muscle crosses the costal arch and runs downward to the level of the umbilicus. It cuts through the skin, superficial and deep fascia and through the anterior sheath of the rectus muscle.

This muscle is retracted medially; then, the posterior sheath and peritoneum are cut longitudinally. It has the same objectionable features as the midrectus incision with this difference only, that instead of a part, the entire rectus muscle may become atrophied.

5. **Kocher Incision (Fig. 37[5]).**

This runs from the lowermost portion of the right costal arch medially and upward, nearly parallel to the costal arch, until it reaches the midline. This incision cuts the sheaths and muscle obliquely; it injures two or three intercostal nerves. The incision is non-physiological, but it does less harm than other non-physiological incisions.

6. **Right Lower Pararectus Incision (Lennander Incision, Battle-Kammerer Incision, Jalaguier Incision) (Fig. 37[6]).**

This incision with slight variations was described by different surgeons: Jalaguier, of Paris described it in 1892, Battle, of London in 1895, F. Kammerer, of New York in 1897, and K. Lennander, of Upsala in 1898.

This incision starts at the level of the umbilicus half an inch medial from the lateral border of the right rectus muscle. It runs downward along the lateral border of this muscle for a distance of four inches. The skin, superficial and deep fascia and the anterior sheath of the rectus muscle are cut longitudinally. The rectus muscle is retracted medially, and the posterior sheath and peritoneum are cut longitudinally. This incision gives a good exposure of the appendix, and can be enlarged upwards if it is decided to work on the gall-bladder. The objectionable feature of it is that the anterior and posterior sheaths are cut in a non-physiological manner.

7. **Fenger Incision (Fig. 37[7]).**

Suggested in 1854. This is used occasionally for gastrostomy and for work on the splenic flexure of the colon. It preceded the Kocher incision, described above, which is analogous to this incision but is done only on

the right side The remarks concerning the Kocher incision may be repeated for this incision

8 **Left Lower Pararectus Incision (Fig 37[8])**

This is performed exactly as the right lower pararectus incision It is used commonly for colostomy operations

9 **Kehr Incision (Fig 37[9])**

Suggested in 1903 This incision runs from the ensiform process downward for an inch, then it turns to the right obliquely downward and laterally for another inch, and then it turns again downward as a midrectus incision reaching to the level of the umbilicus Later, Kehr, not being satisfied with this incision, changed the midrectus limb by making it transverse, reaching to the right costal arch However, in either case the incision is not physiological in the first instance all the limbs are nonphysiological, in the second case, the limbs running vertically and obliquely are non physiological

10 **Oblique Intrarectus Angular Incision (Fig 37[10])**

In English speaking countries this is known as the Mayo Robson incision In Germany, it is known as the Körte incision It starts at the midline one inch below the ensiform process and runs in an oblique direction downward and laterally until it reaches the lateral third of the rectus muscle, then it turns downward until it reaches the level of the umbilicus

11 **Bevan Incision (Fig 37[11])**

Suggested in 1897 In its earliest development this was similar to the Mayo Robson incision, with this difference only, that the small upper limb instead of running obliquely ran transversely, and at the lower end there was a horizontal limb After several modifications, the characteristic feature of which was that the vertical part of the incision was moved closer and closer to the midline, Bevan suggested recently making the vertical part about a quarter of an inch from the medial margin of the right rectus muscle

12 **Audry-Mixter Incision (Fig 37[12])**

This is used by some surgeons when performing colostomy The incision starts at the level of the umbilicus at the lateral border of the left rectus muscle, and runs downward for two inches, then it turns medially until it reaches the midline, then it turns at a right angle downward and runs for two inches, then it turns at a right angle laterally until it reaches the lateral border of the rectus muscle, then it turns downward along the lateral border of this muscle and extends for two inches The quadrangular flap thus formed is reflected laterally, and the anterior sheath of the rectus muscle is cut longitudinally for a length of six inches The rectus muscle is retracted medially and the posterior sheath and peritoneum are incised longitudinally As may be seen this is a longitudinal non-physiological incision

C. FLAP INCISIONS

1. Czerny-Perthes Incision (Fig. 38[1]).

This incision was first suggested by Czerny and later advocated by Perthes. It consists of two limbs, a vertical and horizontal. The vertical

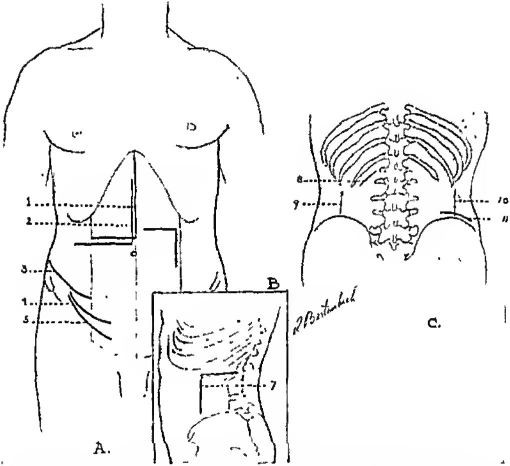

Fig. 38. Different types of incisions. A. 1. Czeray; 2. König-Perthes; 3. Albarran; 4. Hartmann; 5. Israel; 6. Schiassi; B. 7. Bardenheuer; C. 8. For drainage of a pancreatic abscess; 9. Incision for the ascending colon; 10. Incision for the descending colon; 11. Lumbar appendectomy incision.

limb is a midline incision extending from the ensiform process down to one and a half inches above the umbilicus. The horizontal limb extends through the entire width of the rectus muscle. In this way, it cuts through the skin, superficial and deep fascia. The anterior sheath is incised paramedially from the ensiform process toward the umbilicus. The rectus muscle is cut transversely, and the posterior sheath and peritoneum are cut

in a semicircular manner. This incision gives an excellent exposure and does not injure the nerves. The objection is that it cuts the anterior and posterior sheaths longitudinally. *It is used in gall-bladder, duodenal and pyloric surgery.*

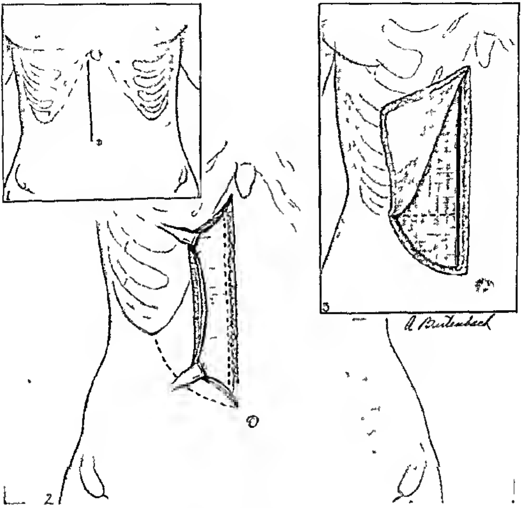

FIG 39 Don incision

2. *König-Perthes Incision* (Fig. 38[2]).

Suggested by F. Konig, in 1912 and later advocated by Perthes. This is the same as the Czerny-Perthes incision with this difference only, that in the latter the vertical part is shorter than the horizontal portion. It has the same commendable and objectionable features as the Czerny-Perthes incision.

3. Don Incision (Fig 39).

Suggested in 1909. The vertical limb of the incision is made one-half

inch to the right of the middle line. It starts from the seventh costochondral junction and ends a little above the umbilicus. The skin, superficial and deep fascia are divided. The anterior sheath of the rectus muscle is divided in the same line, and the medial lip of the anterior sheath is

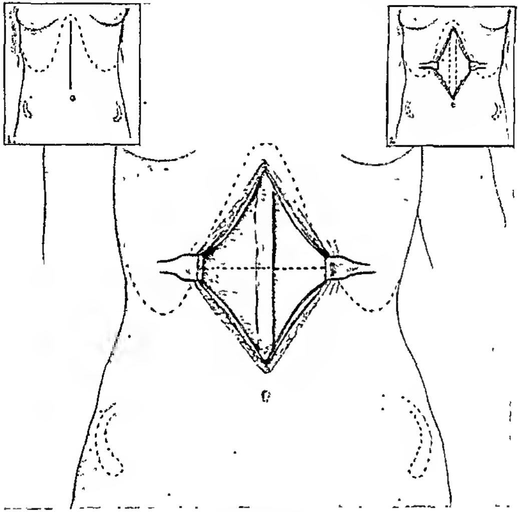

FIG. 40. Winkelmann incision.

separated from the muscle, which is then retracted laterally and separated from its posterior sheath. The posterior sheath and the peritoneum are divided in the same sagittal plane as the skin, fascia and the anterior sheath. Then, from the lowest point of the vertical incision a semilunar incision is made upward and outward to the lowest point of the right costal arch (10th rib) through the skin and fascia only. The rectus muscle, the posterior sheath and peritoneum are cut transversely. The flap thus formed is reflected upward and outward and gives an excellent operative field.

No nerves are injured by this incision, the only objection to the incision is the longitudinal division of the anterior and posterior sheaths

4 Pochhammer Incision

Suggested in 1918 The vertical portion of this incision is the same as in the König Perthes incision The rectus muscle is cut transversely The posterior sheath of the muscle and the peritoneum are incised in a semicircular line This incision is very similar to an incision described a few years previously by Don It has the same commendable and objectionable features as the Don incision

5 Winkelmann Incision

Suggested in 1909 As this is described below, it is actually Sprengel's description of Winkelmann s incision It consists of a longitudinal incision in the midline from the ensiform process to the umbilicus through the skin, superficial and deep fascia (Fig 40[1], left upper insert) These are retracted to the right and the anterior sheath of the right rectus muscle is cut longitudinally The right rectus muscle is retracted laterally and the posterior sheath and peritoneum cut transversely

This incision gives a good operative field particularly if it is enlarged in the same manner on the other side (Fig 40[2] and Fig 40, main picture) However, its objectionable feature is that a longitudinal cut is made through the anterior sheath of the rectus muscle This incision is known in this country as the Sloan incision Sloan described it and brought attention to its merits in 1927

LUMBAR INCISIONS

Recently there has arisen a tendency to approach the abdominal viscera through posterior incisions As a matter of fact these incisions were used for some abdominal operations long before the anterior abdominal incisions were employed For instance, lumbar colostomies were done much earlier than the inguinal type of colostomy The reason for using a lumbar approach in the pre antiseptic time was the fear of peritonitis When aseptic methods were introduced and the fear of peritonitis was lessened, the lumbar and posterior approach in general were abandoned They were revived only in recent times, not on account of the fear of peritonitis but because the surgeons felt that the posterior route lessens the possibility of a post-operative hernia, diminishes the shock and in some cases gives better access to the diseased organs These incisions however find very few followers, and whether they will be widely adopted is questionable In many cases they give a better approach, in some cases they decrease the mortality, and these may be considered as points of advantage However, it is far more inconvenient for the patient to take care of a scar placed in the lumbar region than on the anterior abdominal wall Before describing

the abdominal incisions of the lumbar region let us have a brief anatomical review.

ANATOMY OF THE LUMBAR REGION

Skin (Fig. 31, b).

The fissure lines of Langer run in a semicircular direction and are continuous with the fissure lines of Langer of the anterior abdominal wall.

Superficial Fascia (Fig. 41).

This presents no peculiarities. It is of considerable thickness in which is embedded a considerable amount of fat. Anteriorly, it is continuous with the superficial facia of the abdomen.

Deep Fascia (Fig. 41).

This layer is attached to the supraspinous ligaments and vertebral spines. Laterally, it is continuous with the deep fascia of the abdomen.

Lumbo-dorsal Fascia (Figs. 41 and 42).

This consists of three fascial layers, called respectively the posterior, the middle and the anterior. These three layers unite at the lateral margin of the sacrospinalis muscle and form a ligament which extends between the last rib and the iliac crest and gives partial origin to the internal oblique and transversus abdominis muscles.

The posterior layer extends from the spines of the lumbar vertebræ laterally until at the laternl border of the sacrospinalis muscle it is joined by the middle layer. In the vertical direction it extends between the last rib and the iliac crest. On the chest, it is continuous with the intercostal aponeurosis. From this layer arises the latissimus dorsi muscle (Fig. 41).

The middle layer extends from the ends of the transverse processes of the lumbar vertebræ in a lateral direction. Posteriorly to it is situated the sacrospinalis group of muscles (semispinalis dorsi, longissimus dorsi and iliocostalis), and anteriorly to it is the quadratus lumborum muscle. Just lateral from the line of fusion of the posterior and middle lamellæ of the lumbo-dorsal fascia the internal oblique muscle takes its origin *(Fig. 41)*.

The anterior layer (Fig. 41) is attached to the anterior surface of the transverse processes of the lumbar vertebræ. It lies in front of the quadratus lumborum muscle and behind the psoas major muscle. It joins the fascia formed by the fusion of the posterior and middle layers just lateral to the point of union of the posterior and middle lamellæ. Laterally from this line of union of these three lamellæ the lumbo-dorsal fascia is continuous with the aponeurosis of the transversus abdominis muscle.

Muscles of the Back (Figs. 41 and 42).

The latissimus dorsi muscle lies superficially; its fibers run upward and laterally; along its lateral side extend the vertical fibers of the external

oblique muscle, which run upward and slightly inward. Frequently, the lateral fibers of the latissimus dorsi overlap the medial edge of the external oblique muscle.

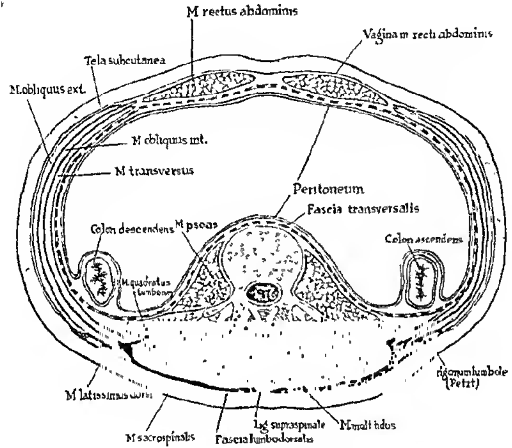

FIG. 41 Cross section of the lumbar region.

The next group of muscles which are exposed after dividing and reflecting the posterior lamellæ of the lumbo-dorsal fascia, latissimus dorsi and external oblique muscles are (enumerating from the median line laterally), the sacrospinalis, the serratus posterior inferior, and the internal oblique muscles. By cutting and reflecting the middle layer of the lumbo-dorsal fascia and the internal oblique muscle the following muscles will be seen (enumerating from the median line laterally): the quadratus lumborum and transversus abdominis muscles. By cutting the anterior layer of the lumbo-dorsal fascia in the innermost part in front of the transverse proc-

esses of the lumbar vertebræ there are exposed the psoas major muscle and, more laterally, the transversalis fascia. Cutting through the transversalis fascia, all the retroperitoneal structures, such as kidney, duodenum, parts of the large bowel which have no mesentery, and the large blood-vessels and their branches, will be exposed.

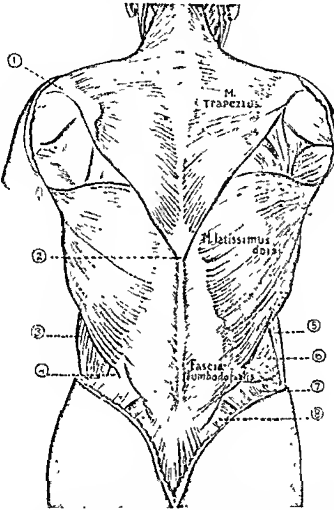

FIG 42. Muscles of the back (after Rauber). 1. Spina scapulæ. 2. Proc. spinosus vertebræ thor. XII. 3. M obliquus ext. abdominis. 4. Trigonum lumbale. 5. M. obliquus ext abdominis. 6. M. obliquus intern. abdominis. 7. M. glutaeus medius. 8. M. glutaeus maximus.

The blood-supply of the posterior abdominal wall is derived from:

a. Subcostal Artery.

This artery, which is actually the twelfth costal artery, takes its origin from the thoracic aorta. It runs laterally, being situated below the last rib. It passes below the lumbo-costal arch to the abdomen, and lies posterior to the kidney and colon and anterior to the quadratus lumborum muscle.

In its further course laterally it pierces the anterior lamella of the lumbodorsal fascia and runs between the transversus abdominis muscle and the internal oblique muscle, and anastomoses with the branches of the lower two intercostal arteries with the lumbar arteries and with branches of the superior epigastric artery

b Lumbar Arteries

There are usually four pairs, occasionally a fifth pair is present They take their origin from the aorta, run in a lateral direction, lying first on the body of the corresponding lumbar vertebra and then between the transverse processes of each two adjoining vertebræ At the lateral border of the interval between each two transverse processes each lumbar artery turns laterally and runs posterior to the quadratus lumborum muscle with the exception of the lowest one which passes in front of this muscle In their further course laterally, they pierce the aponeurosis of the origin of the transversus abdominis muscle, and lie in the interval between the transversus abdominis and the internal oblique muscles Here they anastomose with each other, with the lower two intercostal arteries, the subcostal artery, with branches of the superior and inferior epigastric arteries, with branches of the deep circumflex iliac artery, and with the lumbar branch of the ilio-lumbar artery

c The lumbar branch of the ilio lumbar artery supplies the psoas and quadratus lumborum muscles It anastomoses with the lumbar and deep circumflex iliac arteries

d Deep Circumflex Iliac Artery

This arises from the lateral side of the external iliac artery immediately above the Poupart ligament It runs laterally and upward and a little beyond the anterior superior iliac spine It pierces the transversus abdominis muscle and is continued between this muscle and the internal oblique muscle, where its terminations anastomose with the lumbar branch of the ilio lumbar artery

e *Superficial Circumflex Iliac Artery*

This arises from the front of the femoral artery just below the Poupart ligament It runs laterally and upward as far as the anterior superior iliac spine It supplies the skin of the groin and anastomoses with branches of the deep circumflex iliac artery

NERVE SUPPLY OF THE POSTERIOR ABDOMINAL WALL

a Anterior Ramus of the Twelfth Thoracic Nerve

This branch appears below the twelfth rib and passes laterally and downward behind the psoas major muscle In its further course it lies in front of the quadratus lumborum muscle and behind the kidney and corresponding part of the colon Then it pierces the transversus abdominis muscle and lies between this muscle and the internal oblique muscle until

it reaches the sheath of the rectus muscle. The course of the nerve in the anterior part of the abdominal wall has already been described. It gives off muscular branches to the transverse, internal and external oblique muscles and to the rectus muscle, and also cutaneous branches—the anterior terminal branch, which was described in the anatomy of the anterior abdominal wall, and the lateral cutaneous branch which, while running through the lateral abdominal wall, is still situated in the muscles and only becomes superficial about two inches behind the anterior superior spine. It supplies the skin of the buttock. The twelfth thoracic nerve receives occasionally a communicating branch from the eleventh nerve, and still more frequently sends a communicating branch to the first lumbar nerve.

b. Lumbar Plexus.

From the first, second, third and fourth lumbar nerves arise muscular branches to the quadratus lumborum muscle, and from the second and third lumbar nerves arise muscular branches to the psoas major muscle.

The ilio-hypogastric nerve, which is derived from the first lumbar nerve, traverses the substance of the psoas muscle and then runs downward and laterally in front of the quadratus lumborum muscle and behind the kidney and colon. Then it penetrates the transversus abdominis muscle and runs between it and the internal oblique muscle laterally and downward. About one inch in front of the anterior superior iliac spine it pierces the internal oblique muscle and runs between it and the aponeurosis of the external oblique muscle in the same medial and downward direction. It pierces the aponeurosis of the external oblique muscle about one and a half inches above the subcutaneous inguinal ring and becomes cutaneous. In its course it gives off muscular branches to the oblique muscles of the abdominal wall.

The ilio-inguinal nerve is derived from the first lumbar nerve. It runs nearly parallel with the ilio-hypogastric nerve, but below it, and traverses the same structures. It runs behind the aponeurosis of the external oblique muscle just above the Poupart ligament and becomes superficial after passing through the subcutaneous inguinal ring.

Its muscular branches give innervation to the oblique abdominal muscles. This distribution of its cutaneous branches is described in the anatomy of the anterior abdominal wall.

GENERAL REMARKS ON LUMBAR INCISIONS

From the above description of the direction of the fibers of the skin, fascia and muscles we see that each muscular layer runs in a different direction. If we do not wish to cut the muscle we must make a muscle-splitting incision, and for this reason the opening cannot be very large. Therefore, operations which require a large operative field are not suitable for a lumbar approach. Still, it is possible to perform a great number

of operations through a lumbar approach It is also worth noting that incisions leading to the retroperitoneal structures of the abdomen can be made only in a comparatively narrow area located laterally to the outer border of the lumbosacral muscle since in front of this muscle are situated

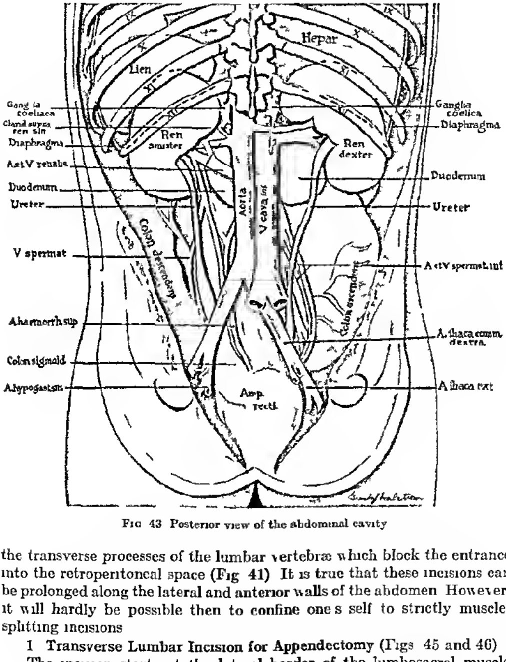

Fig 43 Posterior view of the abdominal cavity

the transverse processes of the lumbar vertebræ which block the entrance into the retroperitoneal space (Fig 41) It is true that these incisions can be prolonged along the lateral and anterior walls of the abdomen However, it will hardly be possible then to confine one s self to strictly muscle splitting incisions

1 **Transverse Lumbar Incision for Appendectomy** (Figs 45 and 46)

The incision starts at the **lateral border** of the lumbosacral muscle and one-half inch above the crest of the **ilium** cutting transversely through

the skin up to the posterior axillary line; ordinarily this is about three inches. The skin, superficial and deep fascia are cut transversely. The external oblique muscle is split in the course of its fibers (*i.e.* in an upward direction); the split muscle is retracted, and the internal oblique muscle is

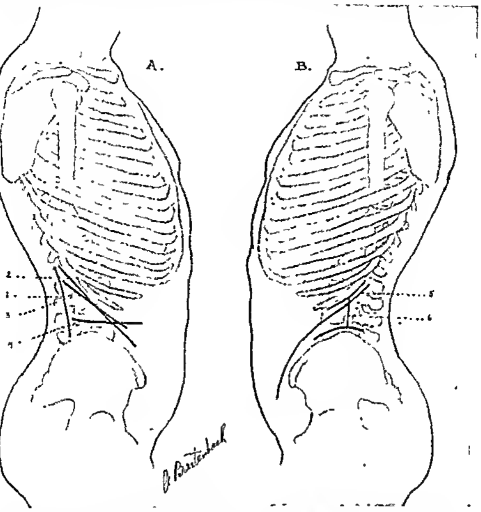

FIG. 44. Different types of lumbar incisions. 1. Simon incision. 2. Bergmann incision. 3. Kocher incision. 4. Péan incision. 5. Israel incision. 6. Bardenheuer incision.

split in the course of its fibers (*i.e.* upward and laterally). These fibers are retracted, and the fibers of the transversus abdominis muscle are split in the course of its fibers (*i.e.* transversely). *It is important not to injure* **the branch of the deep circumflex iliac artery and the ilio-inguinal and ilio-hypogastric nerves.** The ilio-inguinal nerve runs here nearly horizontally very close to the crest of the ilium, and the ilio-hypogastric nerve runs in the same direction, one inch above the ilio-inguinal nerve. The transversalis fascia and peritoneum are cut transversely. This approach is

essentially the same as was described by Edebohls as long ago as 1895 and later reappeared under different names, such as the Sheldon incision, in 1904, and the Mermingas incision in 1931 This incision in some cases may be used even for removal of the cecum

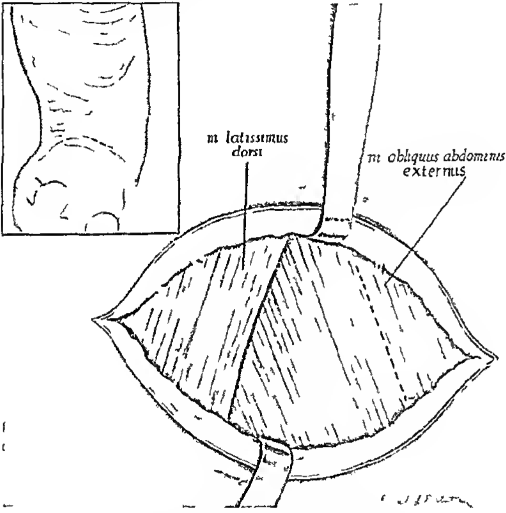

FIG 45 Lumbar appendectomy *Insert*—Skin incision *Main picture*—External oblique muscle is exposed

2 Lumbar Incision for Excision of the Ascending and Descending Colon (Fig 38 C, 9 and 10)

This incision, made in the right lumbar region for resection of the ascending colon and in the left side for resection of the descending colon, was suggested quite recently There is less shock by this method of approach However, the exposure is not as good as in the case of an anterior approach, and we do not believe that it will replace the anterior approach We believe it to be useful only for drainage purposes

3. Lumbar Incision for Removal of the Hepatic and Splenic Flexures. What has been said concerning the lumbar incision for excision of the ascending and descending colon is applicable here.

4. Lumbar Incision for Exposure of the Pancreas, Pancreatic Cysts, and Drainage of the Pancreas (Fig. 38, C, 8).

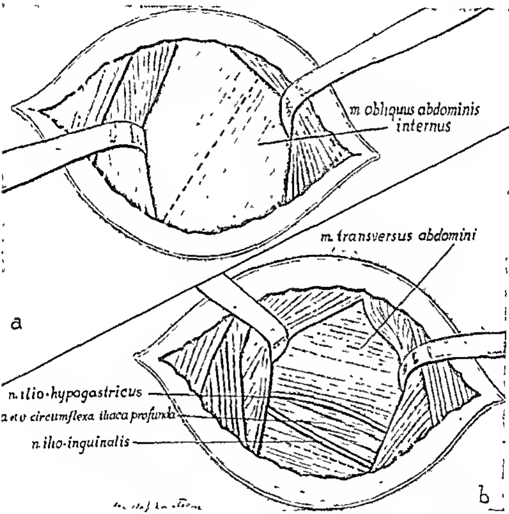

FIG 46 Lumbar appendectomy a. Latissimus dorsi and external oblique muscles are retracted; internal oblique muscle is exposed. b. Transversus abdominis muscle is exposed and ready to be cut.

A left-side lumbar incision is employed for a posterior approach to the tail of the pancreas, and a right-side incision for approach to the head of the pancreas. However, this does not give sufficient room, and for this reason it may be of use for drainage purposes only.

COMBINED ABDOMINO THORACIC OR LUMBO THORACIC INCISIONS FOR APPROACH TO THE SPLEEN LIVER AND SUBPHRENIC SPACE

There are described a number of incisions through the abdominal and thoracic wall designed to expose the abdominal viscera, both intra peritoneal and extra peritoneal In some of these incisions, both the pleura and the peritoneum are opened, in others, only one cavity is opened—either the pleural or the abdominal Still in others, the thoraco abdominal incision does not open either the peritoneal or the pleural cavity, the work being confined to the retro peritoneal or extrapleural spaces A few of these types are described below

I Transdiaphragmatic Celiotomy with Opening of both the Abdominal and Pleural Cavities

This is characterized by opening first the pleural cavity and the forming of adhesions between the costal and diaphragmatic pleuræ as the first stage, and by entering the peritoneal cavity as the second stage of the operation It was first performed by Roser, in 1864, but he did not find followers on account of the dangers connected with it Volkmann, in 1878 and Israel, in 1879, used this route for the removal of echinococcus This operation was generally done in two or three stages in order to prevent infection of the pleural and abdominal cavities The first stage consisted in packing the opened costo-diaphragmatic sinus so that adhesions should form between the costal and diaphragmatic pleuræ and later, as the second stage, the diaphragm was opened

Trendelenburg in 1883 introduced as the first stage, suturing of the diaphragmatic to the costal pleura instead of packing This approach is used now only by some surgeons to evacuate a subdiaphragmatic abscess lying high in the dome of the diaphragm, and an abscess of the postero-superior surface of the liver or of the spleen

Technic

Stage I

Step 1 The skin incision starts at the posterior axillary line and passes along the corresponding rib (8th or 9th) for several inches until the cartilage of this rib is reached (Fig 47, ins)

Step 2 The 8th and 9th ribs are each resected subperiosteally for a length of four inches (Fig 47)

Step 3 The pleural sinus is exposed at the level of the eighth rib and the costal pleura is sutured to the diaphragmatic pleura in a circular manner (Fig 47)

Stage II This is performed several days later

Step 1 The skin is re-opened

Step 2. The periosteum of the ninth rib, the endothoracic fascia, the pleura costalis, the pleura phrenica, the fascia covering the thoracic surface of the diaphragm, the muscular part of the diaphragm, the fascia diaphragmatica (abdominal side), and the parietal peritoneum are incised.

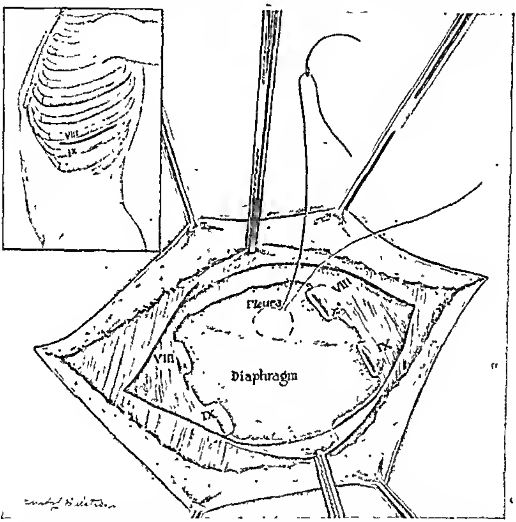

FIG. 47. Transdiaphragmatic, transpleural laparotomy. *Insert*—Skin incision in the 8th intercostal space. *Main picture*—The costal pleura is sutured to the diaphragmatic pleura.

However, many surgeons advise not to use the transpleural route for cases in which the pleural cavity is not involved; they suggest using this method only in cases in which empyema is already present or in which there are already present firm old pleural adhesions. For the rest of the cases (and this constitutes about 70 per cent) they advise using the subpleural approach. This approach can be reached either from the front or from behind. If it is reached from the front, it can be done either with

the aid of permanent resection of some ribs or their cartilages (method of Lannelongue, Monod and Vanverts modification of the Lannelongue method); or of temporary resection (Marwedel, etc.), Or, as suggested by Clairmont and described by his assistant Nather, in 1923, the sub-

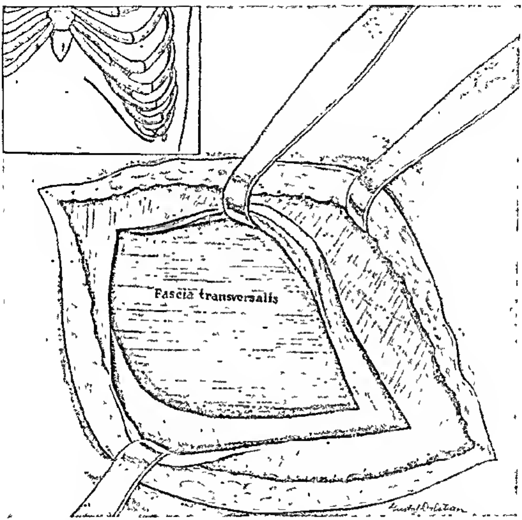

FIG. 48. Transdiaphragmatic laparotomy below the costo-diaphragmatic sinus. Canniot modification of the Lannelongue method.

diaphragmatic space can be reached by incising the anterior abdominal wall parallel to the costal arch, down to the transversalis fascia, then separating this fascia bluntly with a finger in an upward direction until the diaphragm is reached, and then continuing this separation of the fascia and peritoneum from the muscular portion of the diaphragm until its dome is reached.

II. **Transdiaphragmatic Celiotomy below the Costo-diaphragmatic Sinus.**—*Anterior Approach* (*Figs.* 48 and 49).

This method is characterized by opening the peritoneal cavity only. It was introduced by Lannelongue, in 1887. The technic, somewhat modified by Canniot, in 1891, is as follows:

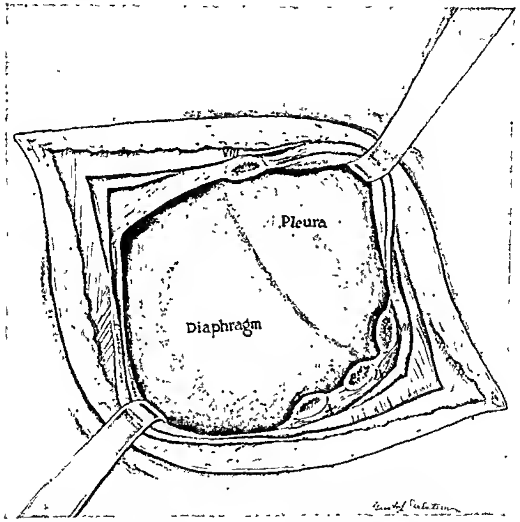

FIG. 49. Transdiaphragmatic laparotomy below the costo-diaphragmatic sinus. Canniot modification of the Lannelongue method.

Step 1. The skin-incision starts three cm. laterally from the ensiform process and two cm. below the costal arch. It is carried laterally as far as the bony portion of the tenth rib (Fig. 48, insert). The skin, superficial and deep fascia, and the external and internal oblique muscles are cut. The costal arch (Fig. 48, main picture) is raised. The attachment of the transverse abdominal muscle and that of the diaphragm are carefully

separated from the cartilages of the arch The transversus abdominis *muscle should not be separated from the bony portions of the ribs, since* the pleura (and the pericardium, if it is the left side) may be opened

Step 2 The cartilages of the eighth ninth and tenth ribs are cut *through The cartilage of the eighth rib should actually be resected (cut*

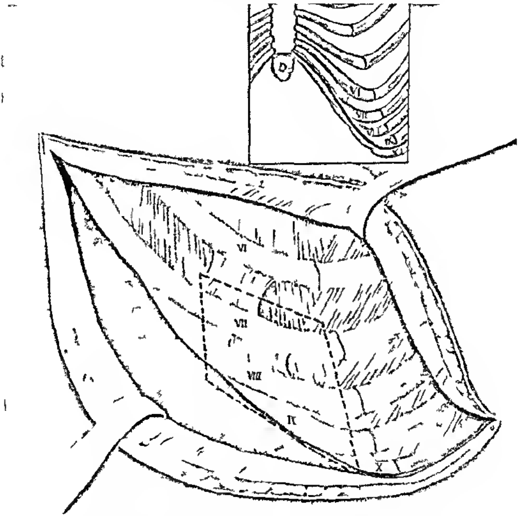

Fig 50 Transdiaphragmatic laparotomy below the costo-diaphragmatic sinus Monod and Vanverts modification of the Lannelongue method

in two places). This will expose a triangular space in which will be seen the fibers of the internal oblique muscle, the transversus abdominis muscle and the diaphragm

Step 3 The internal oblique and transversus abdominis muscles are divided The pleura is now displaced upward and the diaphragm and the peritoneum are divided (Fig 49)

Another modification of the Lannelongue technic was suggested by Monod and Vanverts:

Monod and Vanverts Modification of the Lannelongue Transdiaphragmatic Celiotomy.

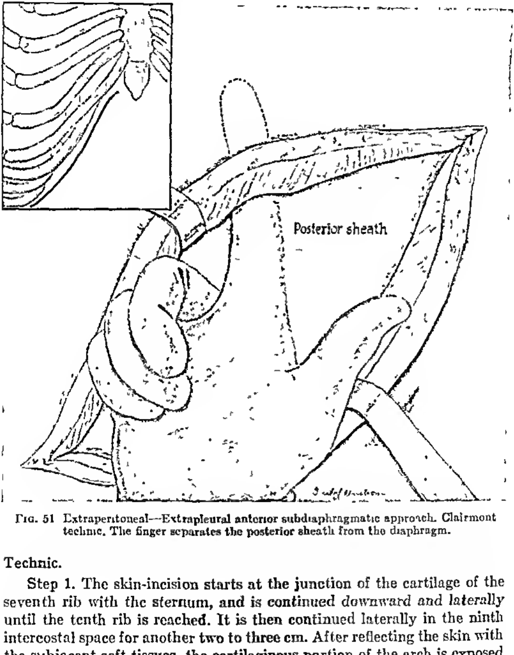

FIG. 51 Extraperitoneal—Extrapleural anterior subdiaphragmatic approach. Clairmont technic. The finger separates the posterior sheath from the diaphragm.

Technic.

Step 1. The skin-incision starts at the junction of the cartilage of the seventh rib with the sternum, and is continued downward and laterally until the tenth rib is reached. It is then continued laterally in the ninth intercostal space for another two to three cm. After reflecting the skin with the subjacent soft tissues, the cartilaginous portion of the arch is exposed (Fig. 50).

Step 2 The exposed cartilaginous portion is cut and reflected downward The attachment of the internal oblique muscle is divided The transverse abdominal muscle and the diaphragm are separated from the inner surface of the cartilages

Step 3 The severed cartilages of the eighth, ninth, and tenth ribs are removed as is also the lower border of the cartilage of the seventh rib

Step 4 The pleura is displaced upward and the diaphragm and peritoneum are opened

This method gives a better approach then the original Lannelongue procedure

III Extraperitoneal—Extrapleural Anterior Approach to the Dome of the Diaphragm or to the Upper Surface of the Liver or Spleen (Clairmont Method)

Technic

Step 1 A skin incision four inches long is made one half cm below and parallel to the costal arch The skin, fascia, external, internal and transverse abdominal muscles are divided

Step 2 The finger begins to separate the transversalis fascia and the peritoneum from the superimposed structures in an upward direction until the costal arch is reached, a hook is then placed behind the arch which lifts it, thus facilitating the further separation of the transversalis fascia and peritoneum from the muscular portion of the diaphragm This is done until the upper surface of the liver or spleen or the dome of the diaphragm is reached (Fig 51)

This approach is indicated for subphrenic abscess or abscess of the liver or of the spleen

In case of posterior approach to the dome of the diaphragm this can be done also either by a transpleural or subpleural method When it is done below the pleura the peritoneal cavity may or may not be entered, depending on where the seat of the pathology is located If it is done for subphrenic abscess or for an abscess of the postero superior surface of the liver, then the operation may be done not only extrapleurally but also extraperitoneally It may be done with resection of the posterior ribs (subperiosteal resection of the IX or X ribs—Method of Elsberg), or with resection of the XIIth rib only (Method of Clairmont)

IV Extraperitoneal, Extrapleural Posterior Approach (Clairmont Method) (Figs 52 and 53)

Technic

Step 1 The skin incision is made above and along the entire length of the XII rib (Fig 52, insert)

Step 2. The XII rib is resected subperiosteally.

Step 3. A transverse incision is made through the entire thickness of the muscles at the level of the first lumbar vertebra until the renal fascia is reached (Fig. 53).

[Thus there is *no danger, whatsoever, of* injuring the pleura.]

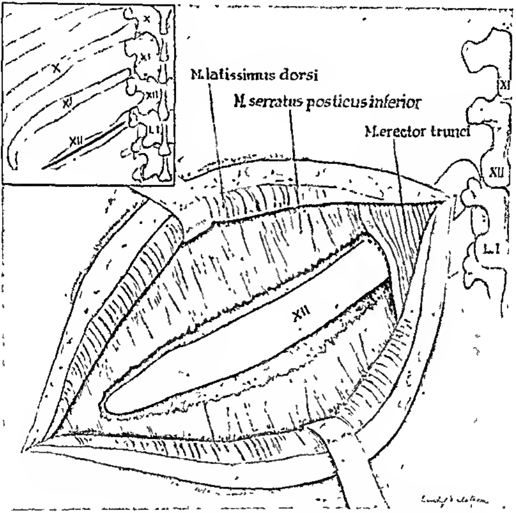

Fig. 52. *Extraperitoneal—Extrapleural subdiaphragmatic posterior approach* Clairmont technic. *Insert*—Skin incision. *Main picture*—The twelfth rib is exposed.

Step 4. A blunt separation of the renal fascia from the super-imposed structures begins in an upward direction. By going upward the finger separates the transversalis fascia and the peritoneum from the muscle of the diaphragm. This is done until either the dome of the diaphragm is reached, or until the upper surface of the liver is reached, depending on the seat of the pathology (Fig. 53).

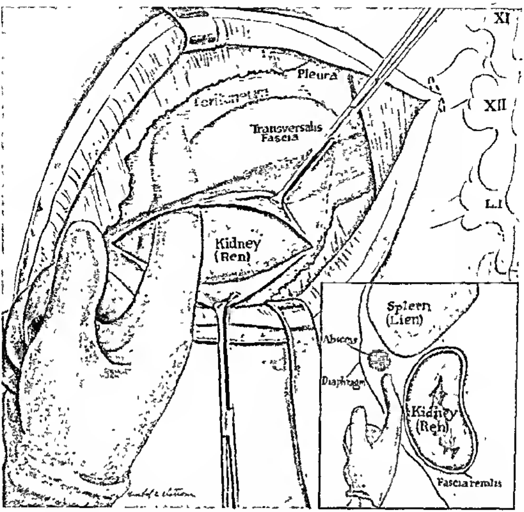

FIG. 53. Extraperitoneal—Extrapleural subdiaphragmatic posterior approach. Clairmont technic. The finger enters through the transversalis fascia and pushes away the peritoneum from the diaphragm.

METHODS OF OPENING AND CLOSURE OF THE ABDOMEN

The technic of opening the abdomen varies according to the type of incision employed. We shall describe in detail only a few methods which will serve as examples for the rest.

Right Midrectus Incision.

Step 1. The tip of a sharp-pointed knife is placed at a right angle to the surface of the skin, which is then pierced by pressing the blade downward. As soon as the tip of the knife penetrates the skin, the surgeon immediately feels that the knife is in the fascia. He then changes the direction of the knife to an angle of 45° to the skin, and presses moderately downward

cutting through the skin for the desired length of the incision. Before finishing the incision he turns the knife again to an angle of 90° to the surface of the skin. [The reason why we advise starting and finishing the incision with the knife held perpendicularly to the surface of the skin is that then the entire length of the incision is uniformly deep; whereas, by

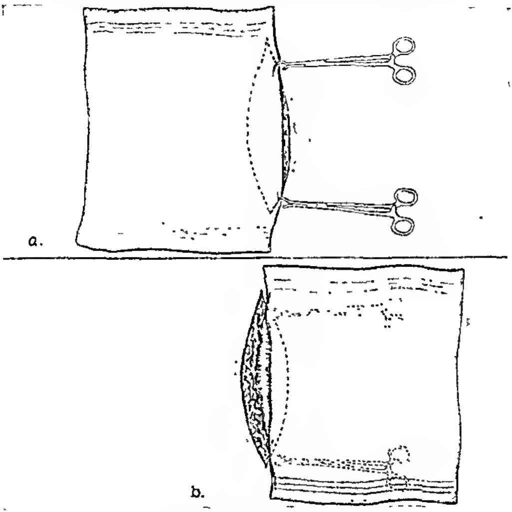

FIG 54 a. Fixing the towel on one lip of the wound.
b. The towel covers the towel-clips.

keeping the blade constantly at an angle of 45°, the beginning and end of the incision are not cut deep enough, and it becomes necessary for the surgeon to deepen the incision at each end. This means at least two additional movements, and it is fundamental in surgical technic not to make unnecessary movements.]

As soon as the skin-incision is made, this knife is laid aside, and an-

other is used for the rest of the operation The reason for doing this is that it is considered contaminated after cutting through the skin The superficial and deep fascia are cut through precisely as described for incision of the skin

Step 2 The bleeding points are clamped with hemostatic forceps using

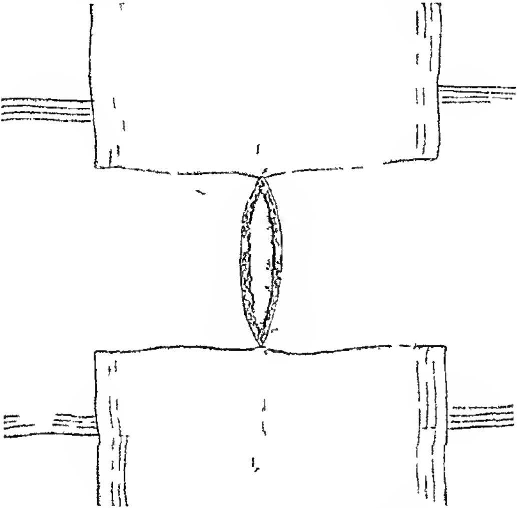

Fig 55 Fixing a towel on each lip of the wound Final view

small artery forceps with small jaws whereby large masses of tissues will not be caught with the blood vessels

[The smaller the amount of tissue which is caught with the blood-vessel, the less sloughing there will be and the neater the operation] In grasping the blood vessels we should avoid catching the skin and this may be accomplished by keeping the forceps perpendicular to the surface of the wound

Step 3. Towels are attached to the lips of the wound as follows: The surgeon catches with a tooth of a towel-forceps the skin of the upper end of the lip on the assistant's side, and with the other tooth the towel. The towel-forceps is then turned through 90°, so that it will rest on the assistant's side of the wound perpendicularly to the length of the

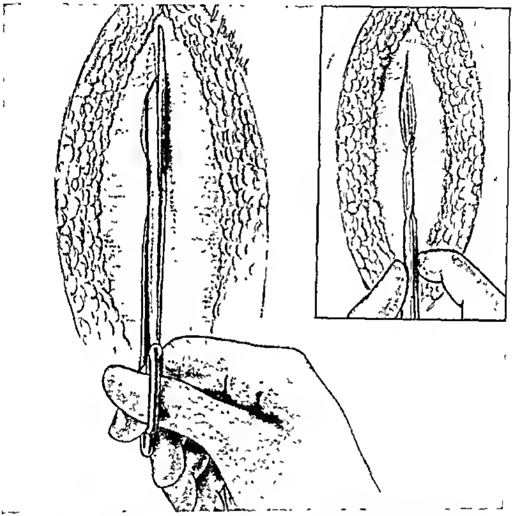

FIG. 56. *Main picture*—Cutting the anterior sheath of the rectus muscle by scissors in an upward direction *Insert*—Cutting the anterior sheath by a knife in a downward direction.

wound (Fig. 54, a). The same is done at the lower end of the incision, and the towel is turned so that it covers the lip of the wound and the towel-forceps on the assistant's side (Fig. 54, b). The assistant repeats this procedure on the surgeon's side. When the towels thus cover the lips of the wound, the surgeon grasps the two towels at the lower angle of the wound with a towel-forceps and his assistant does the same at the upper angle of

the wound The skin should not be caught by these manipulations, the surgeon covers with a towel the forceps at the lower end of the wound and the assistant does the same at the upper end (Fig 55)

The towels may be attached in a different way The surgeon attaches the first and the assistant the second towel as described previously, a

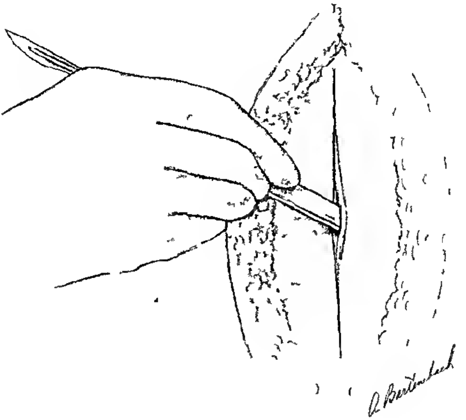

Fig 57 The muscle is split by the handle of the knife.

third towel is then placed so that it covers the entire wound with its lower edge lying just below the lower end of the wound With a towel forceps this end of the towel is attached to the two previously placed towels Then this towel is lifted from the wound so as to cover the last applied towel forceps and that portion of the abdomen below the lower end of the wound incision The same procedure is repeated with another towel which will cover the portion of the abdomen above the upper end of the incision

In this way **no instruments are left uncovered** and the wound is walled off from the skin.

Step 4. The anterior sheath of the rectus muscle is incised with a knife *for a length of one inch in the center of the intended incision.* This incision is enlarged with scissors upward and the knife downward (Fig. 56).

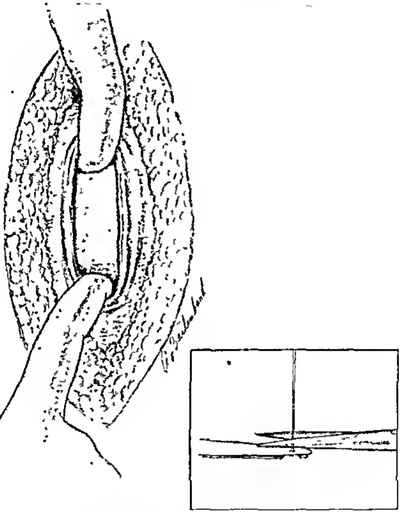

FIG. 58. *Main picture*—The muscle is split by the index-finger of each hand. *Insert*—Cutting the thread above a tissue-forceps.

[The reason why we should not cut with the scissors downward is that in order to do it conveniently the surgeon must change the posture of his body and push his assistant, who is standing at his left hand, aside. As a rule, the surgeon should never change the posture of his body. If he cannot accomplish a maneuver with his right hand in a normal erect posture, he should, *instead of changing the posture of his body,* either execute this

movement by changing hands that is do it with his left hand, or if he cannot do it with his left hand, then he should change the instrument] The length of the *anterior sheath incision* should be one quarter of an inch shorter at each end than the skin incision After the anterior sheath of the rectus muscle is incised the muscle fibers are split with the handle

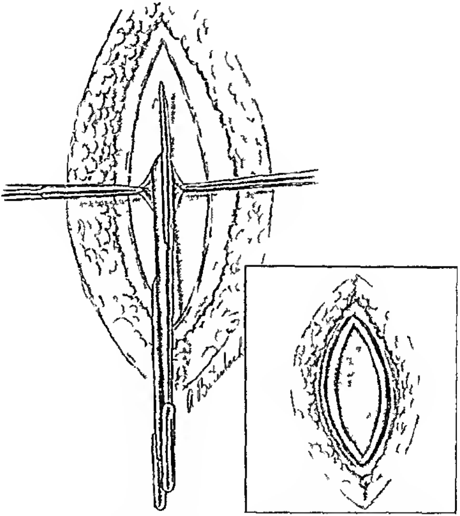

Fig 59 *Main picture*—Incising the peritoneum *Insert*—Showing each deeper layer slightly shorter than the more superficial layer

of the knife for a distance which will allow the index finger of the left hand to enter the opening made by the split muscle (Fig 57) This finger is separated from the handle of the knife for a distance of about two inches The knife is then laid aside and the index fingers of each hand are then separated from each other, thus splitting the muscles along the entire

length of the incision (Fig. 58). All divided blood-vessels are tied.

[We have already spoken of the various methods of tying. There is one suggestion which we would like to offer at this time. Frequently there is a difference of opinion between the surgeon and his assistant as to whether the thread should be cut long or short. In order to avoid these misunderstandings in the operating-room, it is well for the surgeon to arrange beforehand with his assistant to cut the thread immediately above the tissue-forceps which is placed by the surgeon at the proper point (Fig. 58, insert).]

Step 5. The surgeon grasps the posterior sheath (with the transversalis fascia and the peritoneum) by surgical tissue-forceps, and the assistant also grasps it one inch away. With the thumb and index-finger the surgeon feels whether any visceral structures are adherent to the peritoneum. If they are not, he then makes with the knife a small opening in it. The edges of this opening are then caught by the surgeon with an artery-forceps on the assistant's side, and by the assistant on the surgeon's side. Stretching the peritoneum with these forceps, the latter is cut by scissors upward (Fig. 59) and by the knife downward. The length of the incision should be a quarter of an inch shorter at each end than that in the muscle. To avoid unnecessary traumatism of the peritoneum the artery-forceps which grasp it are then removed. [The reason for making the incision in each subsequent layer a little shorter than in the superimposed one is that it is easier then to close the abdomen (Fig. 59, insert).]

CLOSURE OF THE ABDOMEN

The closure of the abdomen as practised today is also a process of surgical evolution. In pre-antiseptic days closure by needle and thread, although known, was not frequently used. At that time, the surgeons preferred to use adhesive tape to bind together the lips of the abdominal wound. None of the layers situated beneath the skin were actually brought together. The reason for this was threefold:

1. The surgeons were afraid to use bloody union methods (needle and thread) because of the danger of piercing the bowel;

2. Adhesive tape could be changed quite frequently; thereby the pus could be evacuated (and in pre-antiseptic days pus was the rule and not the exception);

3. The surgeons believed that in case of increased intra-abdominal pressure, produced by coughing, meteorism, etc., adhesive tape offered greater resistance than suture-material.

However, in the beginning of the Nineteenth Century (1817), Nicolaus Meyer was already teaching closure of the skin by suture and reinforcing this suture by adhesive tape. The peritoneum, muscles and fascia were

still not approximated and fixed to each other Schenk, in 1823, suggested, in the case of a thin abdominal wall, sewing the lips together by a suture penetrating the entire thickness of the abdominal wall including the peritoneum In the fourth decade of the Nineteenth Century, closure by suture was generally employed Yet the surgeons used a suture penetrating the entire thickness of the abdominal wall except the peritoneum, which was not sutured at all Crede was one of the leading exponents of this type of suturing The next step in the development of the closure technic was to close the peritoneum partially and then reinforce this by a suture passing through the entire thickness of the abdominal wall except the peritoneum (Schultze, 1862) About the same time some surgeons began to use the above mentioned suggestion of Schenk by employing sutures which penetrated the entire thickness of the anterior abdominal wall (Spencer Wells, 1859, Gurlt, 1862) For the suture material they used silk, steelwire (*Eisendrahtnahte*), *silverwire*, *catgut* (plain or chromic), silkwormgut, or fishgut The closure was usually done by interrupted sutures

Czerny, in 1880, was already employing the technic of suturing in two layers deep, which included the peritoneum, transversalis fascia, and the transversus abdominis and internal oblique muscles, and superficial, which included the external oblique muscle and the skin

Billroth, in 1884, introduced suturing of the abdomen in three layers deep, the peritoneum only, next, the muscles and superficially, a continuous skin suture

Bogaewsky, in 1896, introduced three layers of a continuous suture with the same uninterrupted thread, the first layer, the peritoneum, the second, the muscles with their sheaths (or fascia, if suturing the lateral muscles of the abdomen), and the skin He used only absorbable material

Koeberle was the first who emphasized the importance of suturing the fascia He sutured it as a separate layer In the United States, W Gill Wylie, in 1887, emphasized the importance of suturing the fascia

Hegar, in *1878 suggested the following suture A bite is taken through* the skin at the edge of the incision Then a bite through the entire thickness of the abdomen, except the skin and peritoneum, half an inch away from the line of the incision on the same side Then a bite through the peritoneum at the edge of the incision of the same side The reverse is then done on the other side In this way the skin and peritoneum of one lip were closely approximated to the skin and peritoneum of the other lip, and the muscles and fascia of the abdominal wall were enveloped between the skin and peritoneum of each lip

Kehrer, in 1894, used the figure of-eight stitch, a bite was taken through the skin of one side, through the anterior and posterior sheaths and peritoneum of the other side, through the peritoneum, posterior and anterior sheaths of the first side, and through the skin on the other side

No muscles were caught in the suture, and the stitches were later removed.

Edebohls, in 1896, sutured the abdominal wall in four layers:

1. Peritoneum and posterior sheath.
2. Recti muscles.
3. Anterior sheath.
4. Skin.

Kosman, in 1895, emphasized the importance of mere approximation, and not strangulation of the tissues by tight ligation.

Kendal Franks introduced the employment of subdermal sutures, and Pozzi improved the technic of its execution.

Kehrer, in 1887, was the first to spread the omentum over the abdominal cavity after he performed Cesárean section. Jesset, in 1891, advocated this procedure as a routine technic for all abdominal operations.

Laroyenne, in 1895, advocated fixing the omentum by its lower angles to the posterior abdominal wall.

TECHNIC OF CLOSURE

Today, the essentials of closure are fairly standardized, but there are still many variations in details as used by different surgeons. The method as used in our work is as follows:

We suture the wall in four layers:

1. The *peritoneum* with the *posterior sheath* are closed with chromic catgut No. 1, by interrupted or continuous suture. In case of interrupted sutures, the distance between the successive bites is one-half of an inch.

2. The muscles are closed by interrupted sutures (plain catgut No. 1). The distance between the bites is one inch.

3. The fascia (anterior sheath) is closed with chromic catgut No. 2, single or No. 1 double thread, interrupted. The distance between the bites is one-half inch.

4. The skin is closed by interrupted horsehair or dermal sutures. The distance between the bites is one-half inch.

In fat patients, and in case large incisions have been made, we place three *"tension-sutures" of silkworm gut*. These sutures penetrate the entire thickness of the abdominal wall except the peritoneum, and are placed immediately after the peritoneum is sutured, but are not tied until the skin-sutures are introduced.

Step 1. The peritoneum and the posterior sheath of the rectus abdominis muscle are caught in four places—at the upper angle, at the middle of the right lip, at the middle of the left lip, and at the lower angle (Fig. 60). [It is important that the posterior sheath of the rectus muscle be caught with the peritoneum, because, if this sheath is not included, then it is possible, that the most important layer, namely the *transversalis fascia* which lies between the posterior sheath and the peritoneum, and which is an impor-

tant factor in the prevention of the development of ventral hernia, will not be sutured.] The forceps is lifted at the upper end, and with a curved round needle the suturing is begun from the upper to the lower end. The bites of the needle should be made in the direction from the lip of the assistant's side to that of the surgeon's side. The sutures are continuous or inter-

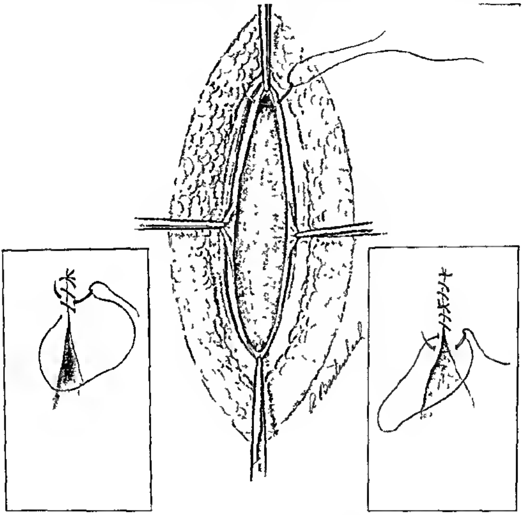

FIG 60 Closure of the peritoneum

rupted, and, if continuous, are locked at each third stitch (Fig. 60, right lower insert). Each bite is made one-quarter of an inch away from the other for the first and second stitches and one-eighth of an inch for each third stitch, which should be locked. [In this way, we prevent extensive puckering of the peritoneum due to the locking of the stitch.] While suturing, the thread is kept at a moderate tension. The lock-stitch is made

by holding the thread in front of the penetrating needle (*Fig.* 60, right insert), whereby there will be eliminated an extra movement for locking. [Instead of locking each third stitch, we may use each fourth stitch as a back-stitch, namely, inserting it just a little proximal to the point of exit of the third stitch (Fig. 60, left lower insert). This avoids puckering. We

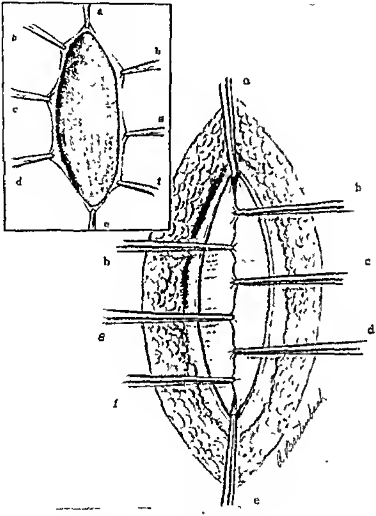

FIG 61. *Insert*—Grasping the lips of the peritoneum. *Main picture*—Throwing the clamps across the incision.

always prefer a back-stitch to a lock-stitch.] When the entire peritoneum is sutured, the free end of the thread is tied to the double thread which is attached to the needle. [N.B. In our discussion, we assume that the surgeon is *standing* at the lower end of the wound. It is always natural and convenient to begin suturing from the farthest to the nearest end of the incision. For this reason, the surgeon begins suturing from the upper or

lower end of the incision depending upon the place where he stands.]

If the bowels protrude and it is difficult to suture the peritoneum, the following *maneuvre may be useful:* A *laparotomy* sponge is placed in the abdomen. The peritoneum instead of being grasped by four artery-forceps as *previously described,* is grasped alternately by *six or eight artery-*

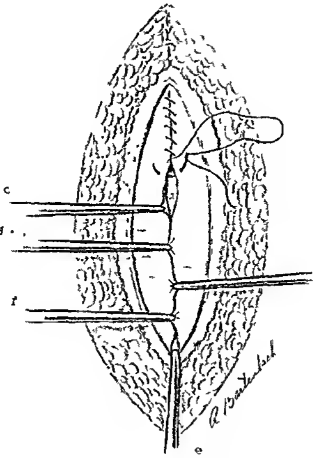

FIG 62. Closure of the peritoneal wound

forceps, depending upon the size of the incision (Fig. 61, insert). Then, these alternate artery-clamps are thrown over the wound (Fig. 61); by this maneuvre the wound is temporarily closed. The suturing begins at one end and when the part thus temporarily closed is reached the forceps closest to the sutured portion is thrown back. This opens a small part of the wound which should be sutured. This procedure of throwing back each clamp as reached is continued until the entire wound is closed (Fig.

62). [The surgeon must not forget to remove the laparotomy sponge before the peritoneum is closed.]

Step 2. After the peritoneum, with the posterior sheath of the rectus muscle, is sutured, the split muscles are sewed by interrupted sutures which are placed at a distance of one inch from each other. Only small bites of

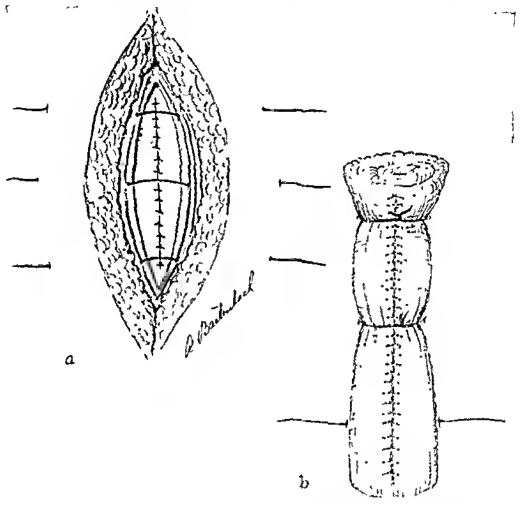

Fig 63 a. Tension-sutures are in place. b. Tying the tension-sutures over a roll of gauze

the muscle are taken and these sutures are not tied tightly but just enough to keep the muscles approximated. [In the case of fat or stout persons, or when there is difficulty in suturing the peritoneum, tension-sutures are useful. These act as splints and are placed before the muscles are sutured together. They are inserted at a distance of two inches apart and also two inches from the skin-edges and include the entire thickness of the abdominal wall with the exception of the peritoneum and posterior sheath; in

this way, the thread includes the entire width of the rectus muscle They are not tied at this time, *but artery forceps are attached to each end* (Fig 63, a) Some surgeons place the tension sutures in front of, instead of behind, the rectus muscle] After the muscle is sutured the skin is well retracted, and the anterior sheath of the rectus muscle is grasped by two forceps, one at the upper and the other at the lower angle [Occasionally, it may be necessary to add a third and fourth artery forceps in the middle of each lip] The sheath is sutured in the same manner as the peritoneum *After the anterior sheath is closed* the skin (*together with the deep and* superficial fascia) is sutured Occasionally we suture the superficial and the deep fascia separately from the skin The latter can be closed either by an over and over continuous suture (Glover suture, Fig 27, b) by a continuous buttonhole suture (Heister suture, Fig 28), by plain interrupted sutures (Fig 27, a) or by metallic clips (Michel clips) We usually use a vertical mattress suture or Michel clips After the skin is sutured, a strip of gauze is placed on the wound and the *tension sutures are tied* (*Fig* 63 b)

Opening and Closure of the Paramedian Incision

This incision was introduced with the intention of having an unaltered muscle interposed between the longitudinal incision of the posterior sheath and peritoneum behind the muscle and the anterior sheath in front of the muscle We will take as an example an incision in the epigastric region The same technic may be employed in the case of a hypogastric incision

Step 1 A midline incision is made from the ensiform process down to the umbilicus If it is necessary to enlarge this incision, it is continued downward in a semicircular manner to the left of the umbilicus This incision should pass through the skin superficial and deep fascia

Step 2 The skin is reflected laterally for an inch, and the anterior sheath of the rectus muscle is incised

Step 3 The inner lip of the aponeurosis is grasped by artery forceps in three places and separated from the rectus muscle (Fig 64 a)

Step 4 The rectus muscle is retracted laterally (Fig 64, b)

Step 5 *The posterior sheath and peritoneum are cut in the same sagittal* plane as the anterior sheath

The closure of the paramedian incision is the same as has been described in closure of the midrectus incision with this difference only, that in the latter procedure the portions of the split muscle are sutured together This of course is not done in the case of a paramedian incision

TRANSVERSE ABDOMINAL INCISIONS

As an example of a transverse abdominal incision, we will describe

one for exposure of the gall-bladder. The skin-incision is made from the lower end of the right costal arch medially to the midline.

Step 1. The skin, superficial and deep fascia are divided (Fig. 65, insert).

Step 2. The anterior sheath of the rectus muscle is cut transversely (Fig. 65).

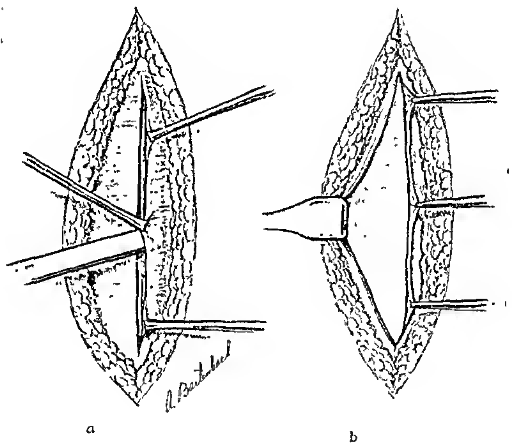

Fig. 64. Paramedian incision. a Anterior sheath is incised. b. The muscle is separated from the sheath and retracted laterally.

Step 3. Each lip of the divided anterior sheath is sutured to the muscle at three places (Fig. 65). It is not necessary to include in the bite the entire thickness of the muscle but just enough to prevent retraction of the fibers after division of the muscle. [Alternative Method.—As soon as Step 1 is completed, a very short longitudinal incision is made along the lateral

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border of the rectus muscle, two artery-clamps are applied across the muscle, and the latter with its anterior sheath is cut between these forceps.]

Step 4. The rectus muscle is cut transversely (Fig. 66).

Step 5. The posterior sheath and peritoneum are cut transversely (Fig. 66).

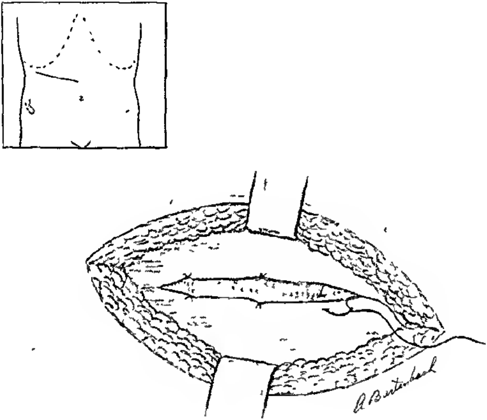

FIG 65 Transverse abdominal incision *Insert*—Skin incision *Main picture*—Anterior sheath is cut transversely, each lip is sutured to the muscle

CLOSURE OF THE TRANSVERSE ABDOMINAL INCISION

Step 1. The peritoneum, with the posterior sheath of the rectus muscle, is grasped at four places with artery-forceps—at the lateral angle, at the medial angle, and at the middle of the upper and lower lips. A continuous suture is made from the medial to the lateral angles (Fig. 67).

Step 2. The upper part of the divided rectus muscle is sutured to the lower part by three interrupted vertical mattress-sutures, as follows: The suture enters the anterior sheath of the rectus muscle and passes through the muscle itself at a distance of one-half inch from the cut edge of the lower lip. Then it penetrates the upper lip in the opposite direction passing

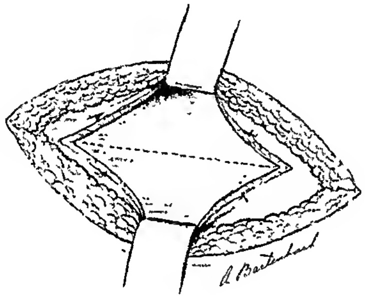

FIG 66. Transverse abdominal incision. The muscle is cut transversely; line of incision in the peritoneum.

through the muscle and the anterior sheath and emerging at a distance of half an inch from the cut edge of the upper lip. Then reversing, it penetrates the upper lip through the edge of the anterior sheath only and then through the edge of the anterior sheath of the lower lip. In this way a vertical mattress-suture is placed. Several such vertical mattress-sutures are inserted and tied (Fig. 67). A few superficial sutures are inserted, con-

necting the lips of the anterior sheath between these mattress-sutures (Fig. 67, lower insert).

Step 3. The skin is sutured by any of the previously described methods.

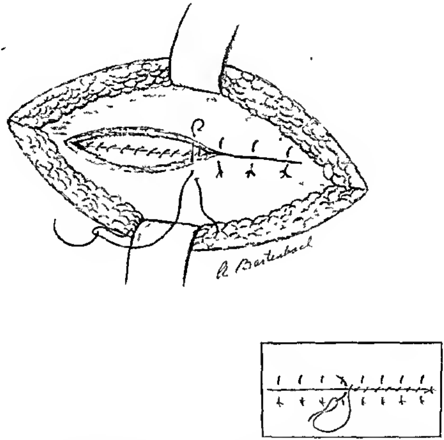

Fig. 67. Closure of the abdomen *Main picture*—The peritoneum is closed, suturing of the muscle by interrupted vertical mattress-sutures *Insert*—Closing of the anterior sheath

COMBINATION ABDOMINAL INCISION

McBurney (Gridiron) Incision.

At the junction of the lateral and middle third of an imaginary line connecting the anterior superior iliac spine and the umbilicus, a perpendicular line is drawn downward and medially for about one and a half inches and upward and laterally for one inch. (Fig. 68, left upper insert). Thus, this incision is about two and a half inches long. Its lower end reaches the lateral border of the rectus muscle. The skin, superficial and

deep fascia are divided. The fibers of the external oblique muscle are split and the aponeurosis of this muscle is cut (Fig. 68, a). The fibers of the split muscle and of the incised aponeurosis are retracted. The internal oblique muscle will then come into view (Fig. 68, a). This muscle is split in the direction of its fibers, and the split muscle is separated by retractors

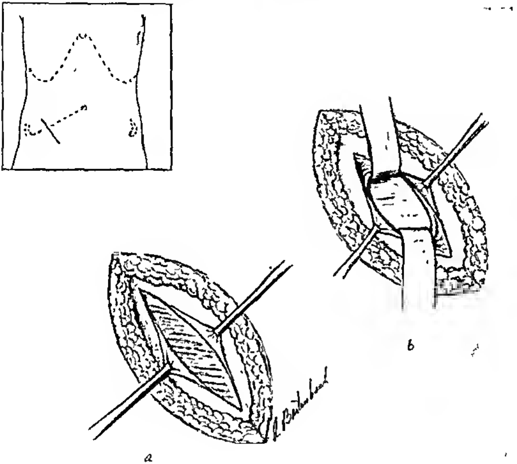

FIG. 68 McBurney incision. *Insert*—Skin incision. a. Aponeurosis of the external oblique muscle is cut and retracted. b. The fibers of the internal oblique muscle are split; the transversalis fascia is exposed.

(Fig. 68, b). The transversus abdominis muscle will then come into view. Its fibers run horizontally, perpendicularly to the long axis of the body. It is split and the transversalis fascia and peritoneum are cut as a single layer by the method which is already described for opening the peritoneum at any other place in the body. The transversalis fascia and peritoneum should be opened in a transverse direction.

Closure of the Abdomen in a "Gridiron" Incision

Step 1. The lateral angle of the peritoneum and transversalis fascia is grasped by one artery-forceps and the medial angle by another The suturing starts at the medial angle and runs to the lateral angle

Step 2 The internal oblique muscle is closed by two or three interrupted sutures

Step 3. The external oblique muscle and aponeurosis are closed by a continuous suture or by interrupted sutures

Step 4 The skin is closed as described above

[**Remarks** In dealing with a "clean case," all the layers may be closed either by a continuous or by interrupted sutures In the case of a gangrenous appendix or in any "pus case," it is always better to close by series of interrupted sutures]

For suturing the peritoneum, we use chromic catgut No 1 single, for suturing the muscles, plain catgut No 1 single, for suturing the anterior sheath of the rectus muscle, chromic catgut No 1 double (20 day), or No 2 single, for suturing the skin, horsehair or dermal, for tension sutures, we use silkworm gut

Removal of Sutures

We remove the tension sutures on the eighth day and the skin sutures on the ninth day

COSMETIC CONSIDERATIONS

Although the cosmetic considerations in making a skin incision on the abdominal wall are not of such importance as on exposed parts of the body, such as the neck or face, nevertheless it is desirable to make the incision in such a manner that it shall not leave noticeable scars This can be best accomplished by making the skin incisions along the fissure lines of Langer

PSYCHOLOGICAL CONSIDERATIONS

In some cases the surgeon is confronted with a dilemma as to whether he is dealing with a right sided pelvic condition or with a case of appendicitis Although, from the surgical standpoint it is best under such circumstances to make a low midline incision, which can be used both for exploratory and for operative purposes, nevertheless in case of a young unmarried woman it will be psychologically more correct to make a right pararectus incision Cases are known, in which low midline incisions in young unmarried women were the causes of a subsequent marital rift

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CHAPTER III

ANATOMY OF THE SMALL AND LARGE BOWEL. INTESTINAL LOCALIZATION

In order to understand the principles of intestinal suturing it is important to know the structure of the intestinal walls. In order to know what portion of a bowel we are dealing with a knowledge of gross anatomy is essential.

The intestinal tract starts from the pyloric ring of the stomach and ends as the terminal part of the rectum, the anus. It is divided into two large subdivisions, the *small* and *large bowel*. The *small* bowel is subdivided into three portions, the duodenum, the jejunum and the ileum.

Duodenum (Fig. 69).—The length of the duodenum is about ten to eleven inches. It begins at the pylorus and ends in the duodeno-jejunal junction. It forms a horseshoe-shaped curve, the convexity of which is directed to the right and downward, and the concavity is directed to the left and upward. The distance between the two ends of the arch is a little more than two inches. The duodenal arch embraces the head of the pancreas. The duodenum is subdivided into three parts:

a. Pars superior. This is one and a half to two inches long. It extends from the pylorus to the neck of the gall-bladder. It is more movable than any other part of the duodenum and is situated intraperitoneally.

b. The *Pars descendens* is three or four inches long. It begins at the neck of the gall-bladder, runs nearly vertically downward to the left of the right kidney and lies on the right side of the second and third lumbar vertebræ. Its anterior surface is covered with peritoneum. The ampulla of Vater is situated in this part of the duodenum. The common orifice of the common bile-duct and of the pancreatic duct opens in the ampulla (*Papilla* major). *Occasionally*, one inch above the *Papilla* major there is situated a separate opening for the accessory pancreatic duct, the **Papilla** minor.

c. Pars inferior. This is the longest and narrowest part of the duodenum. Its length varies from five to seven inches. It runs transversely from the right to the left in front of the inferior vena cava, the aorta and the vertebral column as the **horizontal part,** and then ascends to the inferior surface of the body of the pancreas as the pars ascendens. There it bends forward and forms at the level of the first or second lumbar vertebra the *duodeno-jejunal flexure* and continues as the jejunum. From the duodeno-jejunal juncture a band extends upward and laterally to the base of the transverse mesocolon—the **ligament of Treitz.**

The jejunum starts (Fig. 69) at the duodeno-jejunal junction. It is attached to the posterior abdominal wall by a peritoneal fold, which contains blood-vessels, lymph-vessels and lymphatic glands and nerves. This fold is known as the mesojejunum or the mesentery of the jejunum.

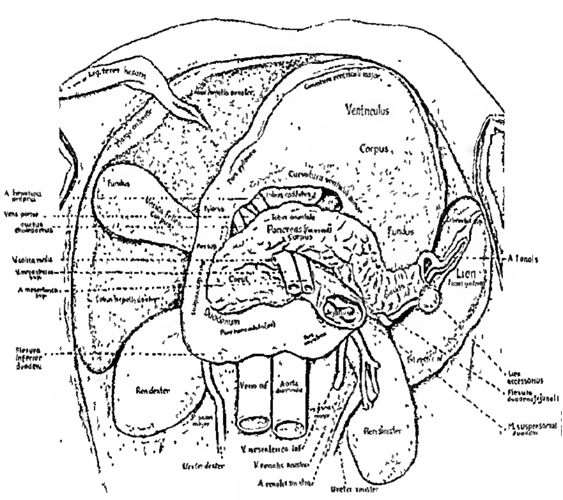

Fig. 69. View of the posterior surface of the stomach, duodenum and pancreas (after Rauber).

The ileum is a continuation of the jejunum. It joins the cecum at the ileo-colic angle. It is attached to the posterior abdominal wall by the meso-ileum or mesentery of the ileum. The points of differentiation between the jejunum and the ileum, the length of their respective parts, and their topographical anatomy will be given below under Intestinal Localization.

STRUCTURE OF THE WALL OF THE BOWEL

a Tunica serosa (Fig 70)

This is a peritoneal covering which surrounds the entire circumference of the bowel with the exception of its mesenteric attachment At that point the tunica serosa is continued as two leaflets of the mesentery, as may

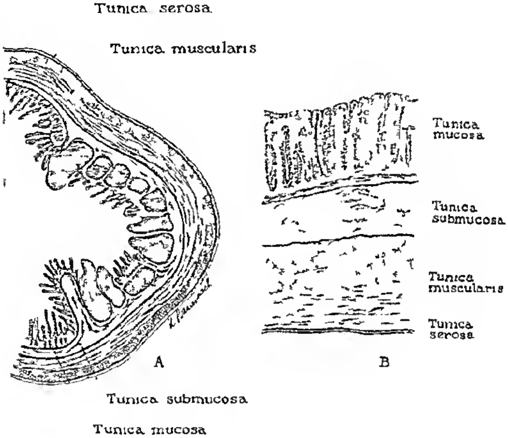

Fig 70 Cross section of bowel A Small bowel B Large bowel

be seen on a cross section In the large bowel the tunica serosa is usually absent on the posterior surface of the colon ascendens and descendens

b Tunica muscularis (Fig 70)

This is a muscular coat consisting of unstriped muscle, and is arranged in two layers, *the outer or the longitudinal, and the inner or the circular* layer The outer layer is much thinner than the inner The muscular layer

of the bowel diminishes in thickness from above downward. It is the thickest at the beginning of the duodenum and the thinnest at the terminal part of the ileum. In the large bowel the relations are reversed. The wall is thinner above and increases in thickness in a downward direction, so that it is the thinnest in the cecum and the thickest in the rectum.

c. Tunica submucosa (Tela submucosa) (Fig. 70).

This is a loose layer of areolar tissue. On its inner side is situated a very thin but strong layer of elastic tissue which some anatomists consider as a separate layer, the muscularis mucosa.

The tunica submucosa (and especially the muscularis mucosa) is very important in intestinal suturing, since suturing through this layer gives real strength to the suture-line.

d. Tunica mucosa (Fig. 70).

This is of a reddish color. This layer is the thickest in the upper part of the duodenum and diminishes in a downward direction. It is the thinnest in the distal end of the ileum. It forms circular folds (plicæ circulares), which are present in the entire length of the small bowel, with the exception of the upper duodenum and the lowest part of the ileum. These folds run perpendicularly to the long axis of the bowel, and they do not extend through its entire circumference. In the large bowel these circular folds of mucous membrane are called plicæ semilunares coli.

BLOOD-SUPPLY OF THE SMALL BOWEL

The blood-supply of the small intestines is derived: (1) from the hepatic artery (through its gastroduodenal branch which gives off as one of its terminal branches, the superior pancreatico-duodenal artery, for the first part of the duodenum); and (2) from the branches of the superior mesenteric artery (inferior pancreatico-duodenal artery, rami intestini tenui, and the ileal branch of the ileo-colic artery).

All the branches which furnish the blood-supply to the small bowel pass between the two layers of the mesentery. Before reaching the wall of the bowel each branch bifurcates. The bifurcating branches inosculate with each other and form arches with their convexities directed to the bowel. Loops formed in this way are called "primary loops" (Fig. 71); from such loops small vessels ("vasa recta") run to the wall of the bowel. If we examine the mesentery at another place, we will find a different arrangement. From the arches of the first loops arise arteries which do not reach the bowel, but bifurcate before reaching it. These bifurcated arteries inosculate with the bifurcated branches of another artery to form another series of loops which are called "secondary loops" (Fig. 71). From these secondary loops arise the "vasa recta." In still other places in the mesentery

we find "tertiary loops"; and, finally, there might be found in the mesentery some places where the arrangement of the blood-vessels is quite irregular, the "primary," "secondary" and "tertiary" loops appearing without any order The knowledge of the arrangement of the blood-vessels

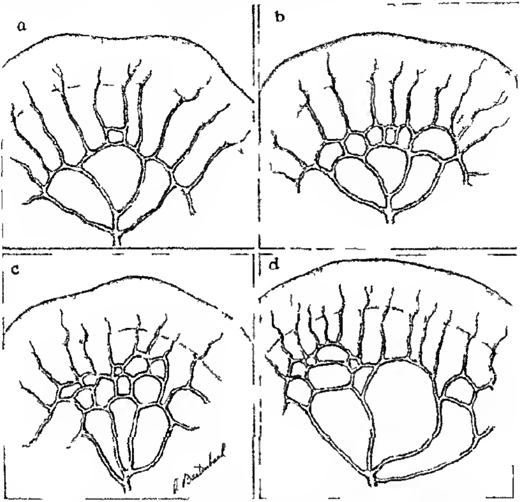

Fig 71 Distribution of the blood vessels in the mesentery a Primary loops b Primary and secondary loops c Primary secondary and tertiary loops d Irregular arrangement of the vascular loops

is very important because it helps in defining what part of the bowel we are dealing with

Monks showed that primary loops are usually found in the upper half of the jejunum; primary and secondary, in the lower half of the jejunum; primary, secondary and tertiary, in the upper half of the ileum; and the irregular arrangement in the lower part of the ileum

The veins are arranged similarly to the arteries

BLOOD-VESSELS OF THE LARGE BOWEL (FIG. 72)

The blood-supply of the large bowel is derived from:

I. Superior Mesenteric Artery;

II. Inferior Mesenteric Artery;

III. Anterior division of the Hypogastric Artery.

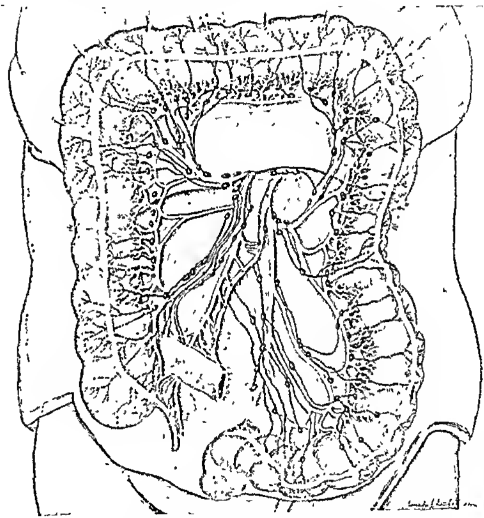

FIG. 72. Blood-vessels and lymphatics of the colon (After Moynihan).

I. Superior Mesenteric Artery.

This vessel gives off:

A. The ileo-colic artery, which itself breaks into five terminal branches:

a. Ileal.

b. Appendicular.

c. Anterior ileo-cecal.

d. Posterior ileo-cecal.

e. Colic.

The distribution of these branches can be seen easily from their names

B Right Colic Artery (Fig 72)

This artery subdivides into two branches which inosculate with the colic branch of the ileo colic artery and with the middle colic artery

C Middle Colic Artery (Fig 72)

This artery runs in the transverse mesocolon It bifurcates into right and left branches The right branch inosculates with the ascending branch of the right colic artery, and the left branch with the ascending branch of the left colic artery The area of *transverse mesocolon surrounded by the* loop formed by the inosculation of the left branch of the middle colic and the ascending branch of the left colic arteries ("Anastomosis Magna" of Riolan) is of a large size and has comparatively a small amount of blood vessels traversing it Hence it is called the "avascular area of Riolan," and in this area of the *transverse mesocolon* the *slit in performing posterior* gastroenterostomy is usually made

II Inferior Mesenteric Artery

This vessel gives off

a **Left colic artery** which bifurcates forming an **ascending** branch which inosculates with the left branch of the middle colic artery and a **descending** branch, which *inosculates with the first sigmoid branch of the* inferior mesenteric artery

b **Sigmoid arteries** These are two or three in number each of which bifurcates into an ascending and descending branch Each ascending branch inosculates with the descending branch of the higher situated artery Each descending branch *mosulates with the ascending branch of the* lower situated artery This is true of the left colic and all the sigmoid arteries except the lowest one which does not bifurcate It inosculates with the descending branch of the higher situated sigmoid artery, but it does not inosculate with the superior hemorrhoidal artery

All these bifurcated branches appear as one vessel which is called the marginal artery Through this artery collateral circulation is easily established *if the left colic or any of the sigmoid arteries are ligated If the* ligation of the artery is made at the place where the inferior mesenteric artery breaks into its two terminal branches (namely, the superior hemorrhoidal and last sigmoid), then the superior hemorrhoidal artery will have no blood supply, and there will be no collateral circulation between it and the marginal artery The point where the inferior mesenteric artery breaks into its two terminal branches is known as the "critical point" of Sudeck The artery should always be ligated above this point *However*, occasionally collateral circulation still may be established between the superior hemorrhoidal and the middle and inferior hemorrhoidal arteries

III. Anterior Division of the Hypogastric Artery.

This vessel gives off:

a. Middle hemorrhoidal artery, which takes its origin from the anterior division of the hypogastric artery, and

b. Inferior hemorrhoidal artery, a branch of the internal pudendal artery (which is a branch of the anterior division of the hypogastric artery).

LYMPHATICS OF THE SMALL AND LARGE BOWEL

An exact knowledge of the lymphatic distribution in the small and large bowel is of the greatest practical importance in the surgery of intestinal maglignancy. The bowel may be invaded by the malignant growth for only a small distance, but the lymphatics corresponding to a larger area may already be invaded. This would make the excision of only the locally affected part useless; a far wider excision would be required.

The lymph is collected from the walls of the small and large bowel into *lymph-vessels, which form four plexuses in the wall of the bowel. Each* plexus is situated in a layer of the wall and carries a corresponding name:

1. Mucous plexus.
2. Submucous plexus.
3. Muscular plexus.
4. Subserous plexus.

Each of these plexuses communicates with the others. The lymph from any plexus passes eventually through the subserous plexus on its way to the lymphatic glands.

The lymph-vessels of the duodenum are few in number. It is difficult to inject them. They drain the lymph into the biliary, sub-pyloric and mesenteric lymph-nodes.

The lymph-vessels of the jejunum and ileum, with the exception of the terminal part of the ileum, drain into the mesenteric lymph-nodes.

The lymph-vessels of the terminal part of the ileum drain into the ileo-colic nodes (Fig. 72).

The lymph-vessels of the appendix, cecum and ascending colon drain into the ileo-colic lymph-nodes (Fig. 72).

The lymph-vessels of the right colic flexure and transverse colon drain into the superior mesenteric lymph-nodes (Fig. 72).

The lymph-vessels of the descending colon, iliac colon and sigmoid flexure drain into the inferior mesenteric lymph-nodes (Fig. 72).

Thus, all the lymph-vessels drain into the mesenteric lymphatic nodes. These lie between the leaflets of the mesentery where they form three main groups:

1. Those lying very close to the intestinal wall.
2. Intermediate nodes lying along the rami intestini tenui. These nodes are larger than those of the first group.

3 A terminal group of mesenteric lymph-nodes

This group consists of large nodes They lie around the stem of the superior mesenteric artery Into them is drained the lymph from the entire small bowel, appendix, cecum, ascending colon, transverse colon and part of the descending colon

THE NERVE-SUPPLY OF THE INTESTINES

This is derived *from the sympathetic system* The nerves accompany the vessels to the wall of the intestine where they terminate These nerves spring from the celiac plexus and the superior and inferior mesenteric plexuses of the sympathetic nervous system Some filaments of the right vagus nerve are also distributed to the upper part of the gastro-intestinal tract

INTESTINAL LOCALIZATION

In surgery of the intestinal tract, it is important to know

a. The position of each part of the intestines in the abdominal cavity

b The length of the small and large bowels

c How to differentiate between the small and large bowels

d How to differentiate between the jejunum and the ileum

e. Which is the proximal and which is the distal part of a given loop of a bowel

f How to find the beginning of the jejunum

g. How to find the cecum

h. How to find the appendix

Among numerous research workers who have contributed to our knowledge in this field, valuable information has been given to us by Monks, Mall, Henke, Sernoff, Stopnitzki, Weinberg, Spivack, etc Many facts given below are taken from the work of the above mentioned writers.

A POSITION OF THE INTESTINES IN THE ABDOMINAL CAVITY

The position of the intestines in the abdominal cavity can be determined from different points of view as follows

1 Holotopic (surface anatomy) method

2 Skeletotopic method, or the relation of the abdominal structures to the skeleton

3 Syntopic method, or the relation of these structures to other visceral structures

1. Holotopic or Surface Anatomy Markings

Monks Method·

The external surface of the anterior abdominal wall is marked by a letter "H," the crossbar being directed from the left and above to the right

and below, so that the umbilicus will be in the center of this line and the length of the line about six inches. Two perpendicular lines are made, one at either end of the first line (Fig. 73). These lines of the letter "H" divide the abdomen into three parts—upper, middle and lower. In the

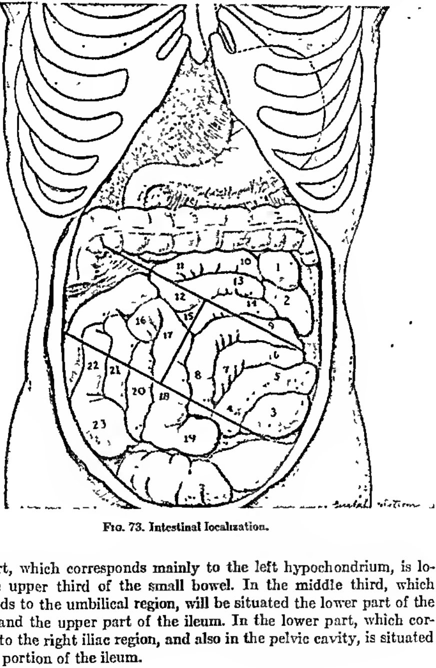

FIG. 73. Intestinal localization.

upper part, which corresponds mainly to the left hypochondrium, is located the upper third of the small bowel. In the middle third, which corresponds to the umbilical region, will be situated the lower part of the jejunum and the upper part of the ileum. In the lower part, which corresponds to the right iliac region, and also in the pelvic cavity, is situated the lower portion of the ileum.

Sernoff Method

As seen from the picture (Fig 73), all the loops of the small intestines lie either in horizontal or in vertical rows The horizontal rows are upper and lower The upper horizontal rows and the left vertical rows, with a part of the middle vertical rows, constitute the jejunum The lower horizontal rows, with the right vertical rows and all the pelvic loops constitute the ileum

2 Skeletotopic Markings

Duodenum

The first part—pars superior, starts at the level of the first lumbar vertebra and extends laterally to the right, and then backward along the body of the first lumbar vertebra

The second part pars descendens, extends vertically down from the first lumbar to the level of the third or fourth lumbar vertebræ parallel and to the right side of the spine

The third part, pars inferior, runs from right to left in front of the spinal column in a slightly oblique direction It reaches the level of the lower end of the first lumbar vertebra on the left side, where it ends in the duodeno jejunal junction

Jejunum and Ileum

According to Sernoff, about 41 per cent of the entire length of the small bowel is situated to the left of the spinal column, about 41 per cent in the pelvis, and 18 per cent to the right of the spinal column The bowel is not closely attached to the posterior abdominal wall, but is connected by a mesentery usually along a line which joins the second lumbar vertebra of the left side with the right iliac fossa (Fig 74) the length of this line is 6 inches However, this line of attachment is not constant Stopnitzki showed the occurrence of other lines of mesenteric attachment (Fig 74)

3 Syntopic Considerations

The duodenum is in contact with the liver, gall bladder, right kidney, right adrenal, and the head of the pancreas It crosses in front of the inferior vena cava and the abdominal aorta, and is itself crossed anteriorly by the superior mesenteric artery and vein Behind the first part (pars superior) lie the common bile duct, the portal vein, and the gastro duodenal artery The anterior surface of the descending part is crossed by the root of the transverse mesocolon, and the anterior surface of the horizontal part by a part of the root of the mesentery of the small bowel

The jejunum and ileum are in contact with the following structures

Anteriorly, with the anterior abdominal wall, from which they are separated by the great omentum. Not infrequently, however, the omentum is folded in and lies on the right or on the left side. In such cases, the

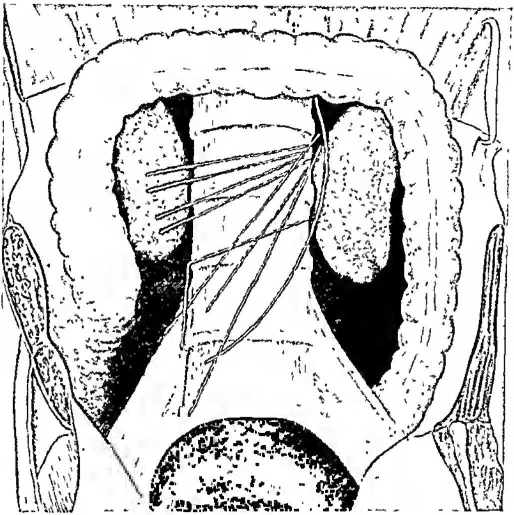

FIG 74. Different lines of attachment of the mesentery to the posterior abdominal wall (after Stopnitzki).

bowel is in contact with the posterior surface of the anterior abdominal wall.

Posteriorly, they rest on the structures which are situated on the posterior abdominal wall, namely, the kidneys, duodenum, and the large blood-vessels (vena cava, abdominal aorta and its branches). Above, they are in contact with the transverse colon and transverse mesocolon. Below, in the pelvic cavity, in men, they lie between the sigmoid and rectum behind and the bladder in front; in women, between the sigmoid and

rectum behind and the uterus and urinary bladder in front. Laterally, they come in contact with the cecum and ascending colon on the right side and the descending colon and sigmoid on the left side.

B THE LENGTH AND CALIBER OF THE BOWEL

The length of the bowel varies, according to the height, age and sex of the individual. The taller the person, the longer the bowel In infants and young children the length of the bowel is relatively larger than in grown persons. The large bowel is one-fourth of the length of the small bowel.

Various authors give different estimates of the size of the bowel. Frederick Treves gives the average length of the small

bowel as	*22 ft. 5 in.*
Cruveilhier " " " " " " "	22 ft. 10 in.
Meckel " " " " " " "	18 ft. 10 in.
Robinson (for a male) " " " " "	23 ft. 4 in.
Robinson (for a female) " " " " "	19 ft. 4 in.

The length of the entire bowel (from the duodenum to the anus):

Cruveilhier	27 ft. 4 in.
Sappey	32 ft.
Kubo (Japan) (for female)	24 ft 3 in.
Kubo (Japan) (for male)	26 ft. 2 in.

Some investigators studied the relationship between the length of the bowel and the height of the body. Their findings are listed below:

Jonnesco gives as 4.2:1 (the length of the small bowel to the height of the body).

Beneke gives it as 3½ .1

The caliber of the bowel is:

Duodenum: Diameter 1.8 to 1.9 inch.

Jejunum (in its upper part): 1.4 to 1.5 inch.

Ileum (terminal part): 1.1 inch.

C. DIFFERENTIATION OF THE SMALL FROM THE LARGE BOWEL

There are several points of differentiation, only three of which are reliable.

Large Bowel.	Small Bowel.
1. Tæniæ longitudinale coli present.	Tæniæ coli absent.
2. Appendices epiploicæ " .	Append epipl " .
3. Sacculation of the wall " .	Saccul. of the wall " .

D DIFFERENTIATION OF THE JEJUNUM FROM THE ILEUM

There is not a marked difference between the end of the jejunum and the beginning of the ileum. The changes come gradually, so that it is

impossible to say where the jejunum ends and the ileum starts. However, if the jejunum and ileum are compared in places where their characteristic features are well marked, it is not difficult to differentiate them:

1. The jejunum is wider than the ileum. The width of the bowel diminishes from above downward. It is widest at the duodeno-jejunal junction and narrowest at the terminal part of the ileum.

2. The jejunum has a thicker wall than the ileum. The thickness of the wall diminishes from above downward.

3. Color of the bowel. The color is brighter in the upper jejunum and fades in the downward direction.

4. Arrangement of the blood-vessels in the mesentery.

Primary loops with long vasa recta are seen in the upper half of the jejunum.

Primary and secondary loops are seen in the lower half of the jejunum, and the vasa recta are shorter than in the upper part.

Primary and secondary and tertiary loops are seen in the upper half of the ileum, and the vasa recta are still shorter than in any portion of the jejunum.

An irregular arrangement (where, in some places, only primary loops are seen, in other places primary and secondary loops, and in still other places in the same vicinity, primary, secondary and tertiary loops) is usually observed in the lower half of the ileum.

5. The thickness and transparency of the mesentery.

The thickness of the mesentery increases from above downward. It is thinnest in the upper mesojejunum and thickest in the lower meso-ileum. In the mesentery which corresponds to the upper seven feet of the jejunum small transparent spots, "lunettes," are found between the vasa recta.

E. WHICH IS THE PROXIMAL AND WHICH IS THE DISTAL END OF A LOOP OF BOWEL?

This is an important point to determine, since in lateral intestinal anastomosis and in case of gastro-enterostomy many surgeons prefer to place the loops of intestines or the stomach and loop of jejunum in an isoperistaltic direction. It is especially important to know this when performing an end-to-side intestinal anastomosis. The simplest and the best method is:

Monks Method (Fig. 75).

A loop of bowel is put on the stretch with the palm of the right hand covering the bowel. The index-finger of the right hand slides along one side of the mesentery and the thumb of the same hand along the other side. The mesentery is palpated between the index-finger and the thumb to find whether it is flat or twisted. A twisted mesentery means that the

bowel has changed its direction. The mesentery should be untwisted. Then, the direction of the bowel will be from above and left to below and right corresponding to the root of the mesentery. The portion of the bowel directed toward the left shoulder will be the proximal part, and the portion directed to the right hip will be the distal end of the bowel.

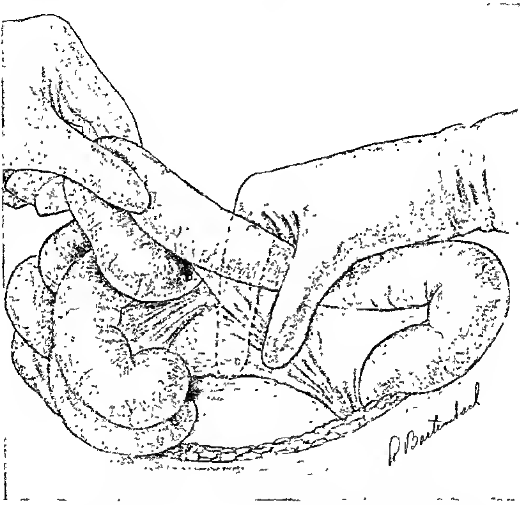

Fig. 75. Monks method of differentiation between the proximal and the distal end of a loop of bowel.

F. HOW TO FIND THE FIRST LOOP OF THE JEJUNUM

An exact knowledge of the first loop is essential in performing a posterior gastro-enterostomy by the "no-loop method."

In the pioneer days of gastro-intestinal surgery, several methods were suggested for locating the first loop. Some of these, in the light of our modern methods were not only non-scientific but even ridiculous. For

instance, one of the earliest methods was to pick up any loop of bowel and follow it in one or the other direction until either the first loop of the jejunum or the terminal part of the ileum was reached. If it was the first loop of the jejunum, all was well. If the terminal end of the ileum was reached, then the surgeon had to follow in the opposite direction until the first loop of the jejunum was finally obtained.

Others used the method of Nothnagel, that is, deciding the direction of the peristaltic wave by placing on the wall of the bowel crystals of sodium or potassium chloride. As soon as the crystals are placed peristaltic contraction occurs and by following the bowel opposite to the peristaltic wave the first loop of the jejunum is reached.

Wölfler, in 1883, and later, Socin, Professor of Surgery in Basel, Switzerland, described an excellent method, which won universal recognition and which in a modified way is described here.

Wölfler-Socin Method (Fig. 199).

The omentum is grasped with the transverse colon by the left hand. These are lifted, placing the transverse mesocolon on the stretch. The right hand is then placed on the vertebral column at the base of the transverse mesocolon. This hand then rests on the body of the second lumbar vertebra. The index-finger of the right hand slides to the left side of this vertebra. **The loop which lies between the index-finger and the left side of the second lumbar vertebra is the first loop of the jejunum.** At the duodeno-jejunal junction, which lies close to this point, a more or less developed band will be seen extending obliquely upward and laterally to the base of the transverse mesocolon; this was described by Treitz and is known as the Treitz ligament.

C. HOW TO FIND THE CECUM

Usually, this is easy, especially, when the abdomen is widely open. However, in cases in which the incision is very small, as in the gridiron incision for appendectomy, it may be difficult. The usual method of placing the right index-finger behind the anterior abdominal wall and moving it laterally until the lateral abdominal wall is reached, then posteriorly until the finger strikes the iliac fossa, then medially, keeping the finger constantly in touch with the iliac fossa until the cecum is reached, may be useful in many cases. The most reliable method however is described by Monks.

Monks Method of Locating the Terminal Ileum and the Cecum (Fig. 76).

The index-finger is placed on the brim of the pelvis, where it feels the pulsation of the external iliac artery; the finger is then moved upward along this artery until the upper margin of the brim of the pelvis is reached,

and this movement is continued upward and somewhat laterally until the finger finds a barrier to further upward movement (Fig 76) The finger then rests on the lower end of the root of the mesentery The thumb is placed on the side of the structure which rests on the index finger and this is

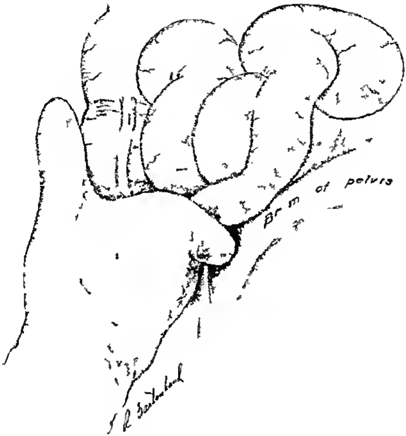

FIG 76 Monks method of finding the terminal portion of the ileum

brought outside of the abdominal wound The structure so caught between the thumb and index finger of the right hand is the terminal part of the ileum located approximately from 3 to 4 inches away from the ileo cecal junction Having located the terminal part of the ileum it is a simple matter to follow along to the cecum

Although this is an excellent method in case of variations in the course of the root of the mesentery it may prove misleading (Fig 74)

II. HOW TO FIND THE APPENDIX

Usually, this is also an easy matter. The base of the appendix is situated on the posterior wall of the cecum, at the point of union of the three tænia longitudinalis. Speaking in geographical terms, it is situated southwest from the ileocecal junction in the normal position of the cecum. However, since we usually, in searching for the appendix, turn the cecum upward, it becomes located in a position northwest from the ileocecal junction.

Difficulty in locating the appendix arises only when that organ is very small—hypoplasia of the appendix, or when it lies completely retrocecal and the cecum is bound to the iliac fossa and but slightly movable. Cases are described in which the length of the appendix was from 1/10 to 1/12 of an inch. The best guide then is to look for the place of junction of the three tænia. In those cases in which the appendix lies retrocecally and the cecum is bound to the iliac fossa, so that the appendix is entirely covered by the cecum, a real difficulty arises. The appendix cannot be seen at all, and at the same time the surgeon does not feel justified in mobilizing the cecum with the possible introduction of infection into the retroperitoneal space, since he is not even certain that the appendix is there. Under such circumstances, a very helpful rule has been suggested by Spivack:

Spivack's Rule.

In about 90 to 92 per cent of these cases, retrocecal appendix is coincidental with attachment of the terminal ileum to the brim of the pelvis. If after careful searching for the appendix, it cannot be found, the surgeon should see whether the terminal part of the ileum is so attached. If so, then nine times out of ten, the appendix is retrocecal. In such cases, the cecum should be mobilized and turned medially so that the posterior wall will face anteriorly. Then the appendix will be seen.

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CHAPTER IV

METHODS OF SUTURING THE STOMACH AND BOWEL

Historical

Suturing of the bowel came into use later than the use of ligatures However, it too has been known since remote antiquity In the Hindu Vedas (*e g* Susruta's Agur-Veda) are mentioned laparotomy and the suture of wounded intestines Celsus (30 B C–30 A D) considered suturing of wounds of the small bowel useless, because it was invariably fatal However, he advised suturing wounds of the large bowel since they gave some hope for recovery Galen (129–201 A D) did not advise suturing of the bowel at all He reserved suturing only for wounds of the stomach Abul-Kasem, the great Arabian surgeon (born in 936 A D), used to suture the wounded bowel with a thread made from the gut of animals He also reports the use, in his time, of the "ant-suture", this consisted in letting a large-sized ant bite the edges of the intestinal wound, and as soon as the jaw of the ant had caught the two lips of the wound the surgeon immediately severed the head from the body, so that the head was used as a suture-material This "ant-suture" was in vogue among the Arabians The "ant suture" was used later by Italian surgeons of the period of the Renaissance In Dalmatia, even recently (at the end of the nineteenth century), the "ant-suture" was used by the laity for sewing superficial wounds It is of interest to note that Michel clips, which were first described by Guillemeau in the XVI Century, were actually a mechanical imitation of the jaws of an ant, which were used for the ant-sutures Further progress in suturing of the intestines was made by the Italian surgeons of the Renaissance period, who introduced a foreign body into the lumen of the bowel and sutured the lips of the wound over it The foreign body later passed *per vias naturales* As a foreign body, some used elder wood (*Sambucus nigra*), some, animal gut (Guglielmo di Salicetti) From Italy this method spread to France, where the four celebrated monks (Archimatheus, Petrosellus, Plátearius and Ferrarius) employed it, using as a prothesis, the trachea of a goose, this suture is known as the "Four Masters Suture" (Sutura quatuor magistrorum)

At first, the surgeons used interrupted sutures, but later they began the use of a continuous suture To Guglielmo di Salicetti (1210–1280) is given the credit of devising the "glover suture" ("furrier's suture") (Fig 27, b and c)

In spite of the fact that surgeons used the intestinal suture for many centuries, their views on suturing were erroneous Thus, for a long time,

they believed that a hole in a small bowel should never be closed for fear of obliterating the lumen of the bowel. A wound of the large bowel, however, could be closed without fear of obliteration of its lumen. Another error which was general even at the end of the eighteenth and the beginning of the nineteenth centuries was that in suturing one bowel to another the mucous layer of one bowel was *sutured to the serosa of the other.*

The real progress in our knowledge of intestinal suture came with the contributions of Jobert and Lembert. The latter showed that good union will follow if the serous surfaces of the loops are brought together. Later experiments, however, have shown that good union of two parts of a stomach or bowel-wall will follow also when the corresponding layers are sutured together namely, serosa to serosa, muscularis to muscularis, and mucosa to mucosa, and that the real holding layer, which gives firm strength to the suture line is the muscularis-mucosa of each side. This must be included in the suture line. **The *serosa in fact* serves *only* as the plastic material which prevents leakage of the gastro-intestinal contents into the free peritoneal cavity.**

DIFFERENT TYPES OF INTESTINAL SUTURE

The methods of intestinal suturing can be subdivided into two classes:

I. *APPROXIMATION OF THE SEROUS LAYERS*

This is an approximation of the peritoneal layers of the bowel. The needle penetrates either the serous layer alone, or the sero-muscular layer, or the seromuscular-submucous layer, or the entire thickness of the wall. Several sutures belong to this class:

1. Lembert Sero-serosa Suture.

This is an interrupted suture which includes the serous layer of each lip of the bowel or stomach (Fig. 77, 1, a).

2. Dupuytren Suture.

This is a continuous sero-serosa suture (Fig. 77, 2, b).

3. Wysler Suture.

This is a seromuscular-seromuscular suture (Fig. 77, 1, b).

4. Wysler-Lembert Suture (Czerny Suture) (Fig. 77, 3, a and b).

This consists of two tiers of sutures: the first tier is seromuscular-seromuscular (actually the Wysler suture); the second or superficial tier, sero-serosa suture (Lembert suture).

5. Albert Suture (Fig. 77, 3, c and d).

This consists of two layers: the first is a through-and-through suture, and the second a sero-serosa suture.

6. Gély Suture—Interrupted (Fig. 77, 5).

This is a suture which embraces the entire thickness of the intestinal wall. The thread armed with two needles first enters at a small distance

from the edge of the wound penetrating from without into the lumen, then runs parallel to the edge of the lip within the lumen, and passing through the wall of the bowel emerges on the same side of the lip The needle on the other end of the thread penetrates from without into the

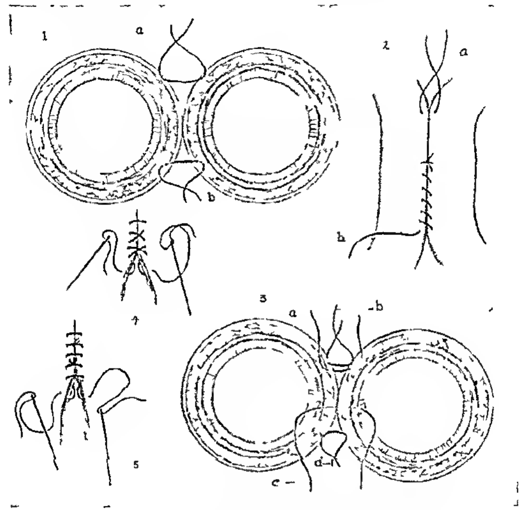

FIG 77 Different types of intestinal suturing

lumen through the other lip, it then runs parallel to the edge of the lip and passing through the bowel-wall emerges on the other side, when the ends are tied The edges are thus approximated by their serous surfaces.

7. Gély Suture—Continuous (Fig 77, 4).

The thread is armed with two needles Each needle penetrates the thickness of the wall from without inward Then it traverses the lumen for about one-third of an inch parallel to the free edge and emerges by penetrating the entire thickness of the wall. The threads are then crossed

and the needles enter as described before, repeating the previous step. Then the ends are tied.

8. *Appolito Suture (Fig. 78, a, b).*

This is a modification of the Gély suture. It embraces the entire thick-

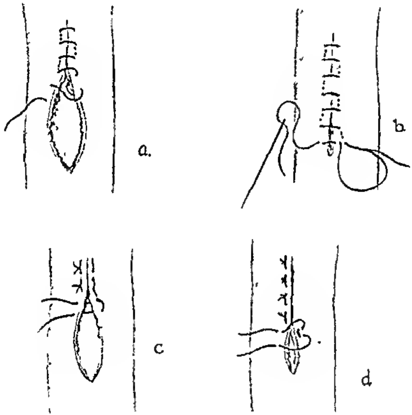

FIG. 78. Different types of intestinal suturing. a, b Appolito suture, c. Halsted mattress-suture, d. Gould reverse mattress-suture

ness of the wall. It is made with one needle and a double thread. At the end of the thread is a knot.

The technic is as follows:

The needle passes from the inner to the outer side of the lip one-third of an inch away from the edge of the lip. It crosses over the gap of the wound and enters from without into the lumen of the bowel by piercing the opposite lip. Then the needle passes from within outward by piercing

the second lip a little distance from its entrance, again crosses the gap of the wound, and pierces the first lip at the distance of one-third of an inch from the edge of the lip from without inward. These steps are repeated until the entire wound is closed. Then, on the side opposite to which the first stitch was inserted, one thread of the double thread is cut. The needle makes a Lembert seromuscular-seromuscular bite, and the two ends are tied. Thus, *loops are formed on the inner side of the bowel running parallel* to the edges of the lip. This suture closes the wound in folds, whereas Gély's suture closes it in a straight line. It is simpler in execution, but is not as safe.

9. Halsted Mattress-suture (Fig. 78, c).

This is a modification of the Emmert suture, including the seromuscular layer only. It is made in the following way:

A seromuscular bite is taken on one side of the lip one-eighth of an inch away from the edge. Another seromuscular bite is taken on the other lip, also one-eighth of an inch away from the edge of the lip. Another seromuscular bite is then taken on the same lip on which the second bite was made, and the fourth bite is taken on the lip on which the first bite was made. There is thus a loop on one lip with the two ends of the thread emerging on the other lip of the bowel.

10. Gould Reverse Mattress-suture (Fig. 78, d).

This is a seromuscular suture which has the inverting effect of a Lembert suture and the strength of a mattress-suture. It is done in the following way:

A seromuscular bite is taken on one lip toward the wound. A second seromuscular bite is taken on the other lip, also toward the wound. A *third seromuscular bite is taken on the same lip where the second bite was* made but away from the wound. A fourth bite is taken on the same lip where the first bite was made, and also away from the wound. Each bite should be at a distance of one-eighth of an inch from the edges of the wound and one-eighth of an inch away from each other.

11. Cushing Right-angle Suture (Fig. 79, a, b, c).

This is a modification of the Appolito suture, penetrating the seromuscular layer only. It is performed in the following way:

A seromuscular bite is taken one-eighth of an inch away from the edge of the lip in the direction opposite to the intended line of suturing. The thread is crossed at a right angle to the wound, and a seromuscular bite is taken on the other lip parallel to the wound and in the direction of the line of suture (reversed U-shape suture). The ends are then tied. The thread again is taken across the wound at a right angle and pierces the seromuscular layer of the first lip parallel to the wound, and so on. The thread must always be drawn along the line of suture and in the direction of suturing. Then the line will be smooth and there will be no puckering.

To tie the end of the Cushing suture, the thread which is between the next to the last stitch and the last stitch is grasped; this forms a loop, which is drawn tight and tied to the single thread which hangs from the needle (Fig. 79, c).

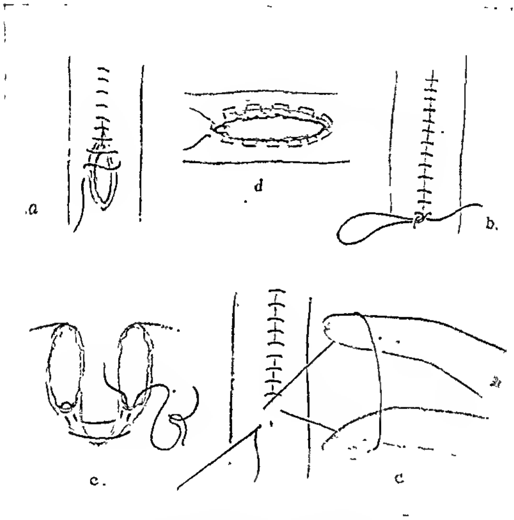

Fig. 79 Different types of intestinal suturing. a, b, c. Cushing suture; d. Purse-string suture; e. Maunsell mesenteric stitch.

12. *Purse-string* Suture (Fig. 79, d).

This is a continuous seromuscular suture inserted circularly about one-eighth of an inch from the edge of the wound. The distance between each two bites is about one-half inch. This suture can be placed before opening the bowel or the stomach.

13. Maunsell Mesenteric Suture (Fig. 79, e).

The thread passes through the entire thickness of the inner lip at the

mesenteric border of the bowel. It will then lie in the triangular space between the two leaflets of the mesentery. The thread then passes successively through the inner leaflet of the mesentery of this loop, the inner leaflet of the mesentery of the other loop, the inner lip of the second loop,

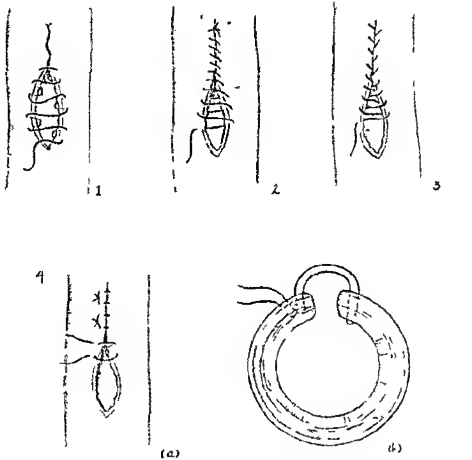

Fig 80 Different types of intestinal suturing 1 Connell suture, 2 Glover suture, 3 Bell suture, 4 (a, b) Jobert suture

the outer lip of the second loop, the outer leaflet of the mesentery of the second loop, the outer leaflet of the mesentery of the first loop and the outer lip of the first loop. Thus, the ends of the thread will lie in the lumen of one gut and the loop of the thread in the lumen of the other gut. The ends are then tied.

14. Connell Suture (Fig. 80, 1)

The thread passes through the entire thickness of the wall of the bowel from within outward in one lip of the wound. Then it crosses the wound and passes through the other lip from without inward. It then emerges by passing through the thickness of the wall from within outward, so that a loop is formed within the lumen of the bowel. Then the thread crosses the wound again, and the process is repeated until the wound is closed. Each bite is at a distance of one-eighth of an inch from the other and about the same distance from the edge of the wound. As may be seen, *it includes the entire thickness of the wall* and *closely* resembles the Gély, continuous suture, save that in the latter method two needles are used.

15. Jobert Suture (Fig. 80, 4, a, b).

This suture was described by Jobert (1799–1867) in 1824. Thus, it preceded the Lembert (1802–1851) suture, which was suggested in 1826.

Technic

It starts as a seromuscular suture on one side of the wound, then crosses the wound and enters the lumen of the bowel by penetrating all the coats from without inward. It then passes from within outward by penetrating the thickness of the same lip of the bowel. Then it crosses the wound and enters as a seromuscular suture of the first lip. When this stitch is tied hemorrhage will be checked in one lip by the penetrating suture and in the other lip by compression of the entire thickness of the wall *of the second lip to the first lip. At the same time, there* will be *a serous* approximation of the lips of the wound.

II. APPROXIMATION BY THE MUCOUS LAYERS

1. Glover's Suture (Furrier's Suture) (Fig. 80, 2).

This suture was first described by Guglielmo di Salicetti. It is a continuous suture. It starts by penetrating the entire thickness of the wall of the bowel from serosa to mucosa on one side and from mucosa to serosa on the other side. The ends are then tied. The suture is then carried over the edge of the wound and the process repeated as often as necessary. This is a very effective hemostatic suture, especially when each bite, or every third bite is locked, or if, from time to time, a back-stitch is taken.

2. Buttonhole Suture (Fig. 27, a).

This was introduced by Laurentius Heister (1683–1758) in 1739. It is a modification of the glover's suture. It penetrates the entire thickness of the wall. The difference between this and the glover's suture is that before crossing a half-stitch is taken in the loop. This suture is useful in approximating the edges of the wound where approximation only is needed. Where tension is needed, this suture is not reliable. Therefore, it is of value in *suturing the skin but not the stomach or intestines.*

3. Bell Modification of the Glover Suture (Fig. 80, 3).

This was described by Bell in 1794 The thread passes through the wall from within outward exactly as in lacing a shoe In the United States this is known as the "baseball suture"

All the sutures described above are either interrupted or continuous Both forms have advantages and disadvantages Thus in

Interrupted Suture

1 Breaking of a stitch is not so dangerous

2 Leakage of contents is more possible in case of an interrupted than of a continuous suture

3 No purse string action is possible in this type of suture

4 It is less rapid than the continuous suture

Continuous Suture

1 Breaking of one stitch is dangerous because the entire chain is loosened

2 Leakage of contents is less possible than in the case of the interrupted suture

3 Purse string action might be present if improperly applied

4 It is more rapid than the interrupted suture

However if properly placed, all the advantages and disadvantages of each method can be evenly balanced so that in most of the cases one method may be substituted for the other

MECHANICAL DEVICES IN GASTRIC OR INTESTINAL SURGERY

Today these are very seldom used but in pre antiseptic days when fast work was so important since it lessened the chances of contamination of the wound they were of great importance and more advantageous than the use of sutures The methods are all based on the same principles

1 Two serous surfaces brought together form adhesions, *i e* unite

2 Living tissue compressed between two surfaces to a definite degree will slough away

The first who suggested a mechanical device was Denans a French surgeon from Marseilles His device was published in 1826, two years after Jobert published his work on union of serous approximated surfaces The Denans appliance consisted of three silver rings two of which had a width of three tenths of an inch and a diameter of the lumen of the bowel The third had the width of six tenths of an inch and a diameter smaller than the other two rings A ring of the lesser width was introduced into the lumen of each bowel, leaving about one third of an inch free, which was turned inside as a cuff, so that the serous surface presented in the lumen of the bowel The third ring was then introduced into the lumen of the two bowels so that the cuff of each bowel was compressed between its own ring and the common ring for the two bowels Due to compression, the cuffs sloughed away and the rings were expelled *per vias naturales*

Denans' device was followed by numerous appliances devised by different surgeons, such as the Bobrik method, described in 1850, the Béranger-Ferand method, described in 1870, the Senn bone-plate, described in 1887, the Mayo Robson decalcified bone bobbin, described in 1892, the Murphy button, described in 1892, and the A. Ramaugé method, described in 1893. The last two methods were described evidently independently at the same time. Murphy described his method in December, 1892, and Adalbert Ramaugé, of Buenos Aires, his method in the early part of 1893. They have a striking resemblance, and at the same time both of them are a clear evolution of Denans and the Béranger-Ferand appliances.

The mechanical devices are little used now. Occasionally a Murphy button is used in the case of ileo-sigmoidostomy. The reason for abandoning the mechanical devices is that occasionally they give way before union takes place, with resulting peritonitis. Secondly, occasionally the mechanical device does not slough away but blocks and obstructs the opening. As the Murphy button is still occasionally used, it will be described in the following chapter.

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CHAPTER V

INTESTINAL ANASTOMOSIS

Intestinal anastomosis is an artificial communication between the lumen of two bowels. There are three possible ways of establishing such communication:

A. Lateral intestinal anastomosis.
B. End-to-end anastomosis.
C. End-to-side anastomosis.

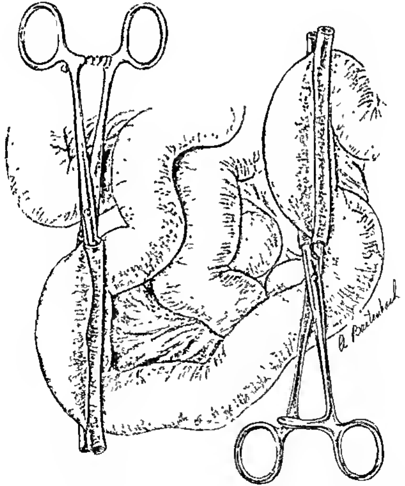

FIG. 81. Lateral intestinal anastomosis Loops of the bowel to be anastomosed are clamped.

A LATERAL INTESTINAL ANASTOMOSIS

This was first performed by Maisonneuve (1809–1897), in 1852

Indications.

The operation is performed either for short-circuiting a loop of bowel, the lumen of which is narrowed, or as a step in some other operative pro-

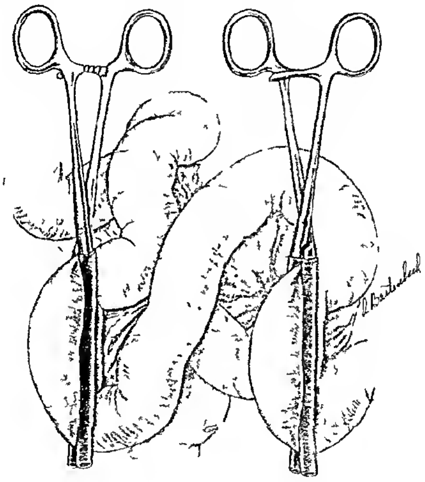

FIG 82 Lateral intestinal anastomosis The loops are placed in an isoperistaltic direction

cedure Thus, in the case of anterior gastro-enterostomy it is always advisable to supplement the operation by a lateral intestinal anastomosis

The methods of performing the operation may be subdivided into two groups

I Anastomosis by suture methods,
II Anastomosis by mechanical devices.

With the perfection of suture methods, the mechanical devices are now little used.

I. LATERAL INTESTINAL ANASTOMOSIS BY THE SUTURE METHOD

Step 1. An intestinal loop proximal to the place which should be short-circuited is grasped. The intestinal contents of this portion are squeezed

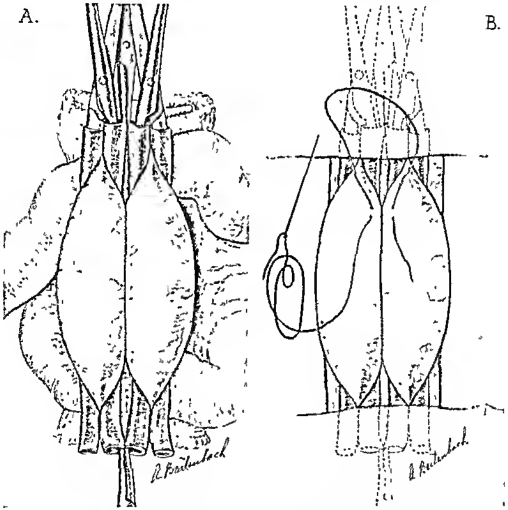

FIG. 83. Lateral intestinal anastomosis. A. The clamps are fastened to each other, B. Beginning of the seromuscular suture line.

out by the index-finger and thumb of each hand. An intestinal clamp, the blades of which are covered with rubber tubing, is placed axially on a fold of the bowel-wall. The handles of the clamp rest on the assistant's side of the table. The length of the fold should be about four inches, and the clamp should compress the wall of the bowel and not the mesentery (Fig. 81). The blades should not be tightly locked, only sufficiently to prevent

leakage of the intestinal contents but not to shut off the blood-supply If the wall of the bowel becomes dark, the clamp should be loosened slightly

Step 2 Another intestinal clamp is placed distally on a loop of bowel several inches away from the loop which is to be short-circuited, with the handles of the clamp resting on the surgeon's side of the table This clamp,

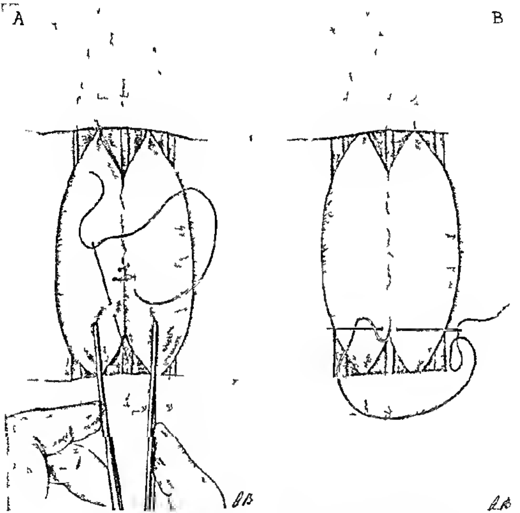

FIG 84 Lateral intestinal anastomosis A The tissue forceps is used alternately as a retractor and as a needle holder B The last seromuscular stitch is locked

which grasps the distal loop, is rotated in such a manner, that the handles rest also on the assistant's side (Fig 82) Thus, the peristalsis in both loops will move in the same direction ("isoperistaltic") and the clamps will rest side by side with the blades directed toward the surgeon and the handles toward the assistant (Fig 82) A moist sponge is placed between the clamps This will prevent the contamination of the region between the

clamps when the bowel is opened. The rubber tubing on the adjoining blades is grasped by a mosquito forceps (Fig. 83, A). This will keep immobile the relative position of the loops of the bowel. The tubing of the handles of the clamps is also grasped by a mosquito clamp [fastening of the blades is not necessary if the clamps are so contructed that this is

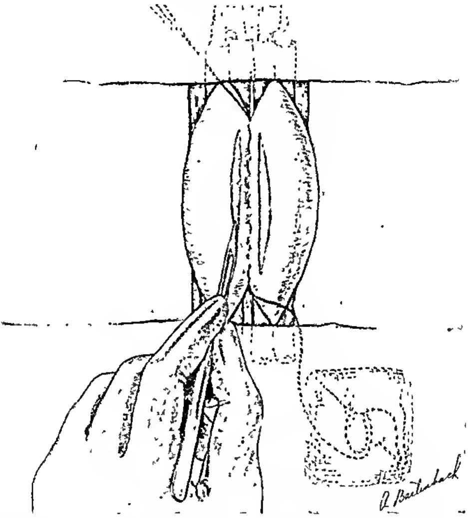

Fig. 85 Lateral intestinal anastomosis. Cutting the seromuscular layer with the right hand on the right loop and with the left hand on the left loop.

done by a mechanical device]. The handles of the clamps, the portions of the blades not engaged in holding the bowel, and the operative field on each side of the clamps are covered by towels moistened in warm normal salt-solution. After this is done, the operative field will consist of two loops of bowels surrounded on all sides by towels (Fig. 83, B).

Step 3. A seromuscular suture of the Cushing type is begun from the

point most distal to the surgeon. The suture is made with a straight needle and without a needle-holder. The first stitch is a reversed "U" shaped stitch (Fig. 83, B). The arms of a tissue-forceps is placed between the adjoining walls of the intestinal loops, and is used as a retractor while inserting the needle into the seromuscular layer, and as a needle-catcher as soon as the

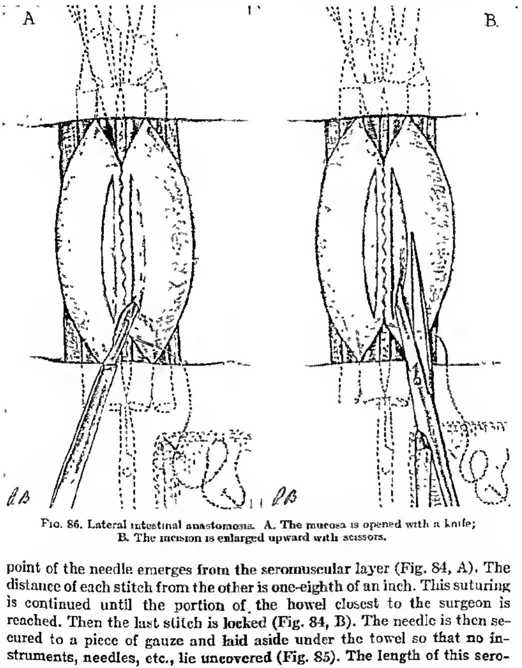

FIG. 86. Lateral intestinal anastomosis. A. The mucosa is opened with a knife; B. The incision is enlarged upward with scissors.

point of the needle emerges from the seromuscular layer (Fig. 84, A). The distance of each stitch from the other is one-eighth of an inch. This suturing is continued until the portion of the bowel closest to the surgeon is reached. Then the last stitch is locked (Fig. 84, B). The needle is then secured to a piece of gauze and laid aside under the towel so that no instruments, needles, etc., lie uncovered (Fig. 85). The length of this seromuscular suture should be about three inches.

Step 4. The surgeon now puts on the stretch the end of the seromuscular suture closest to himself, and the assistant does the same with the end closest to him. A seromuscular incision is then made with a knife for a length of two and one-half inches on each loop. The knife is held in the right hand while making this incision on the right loop, and in the left hand

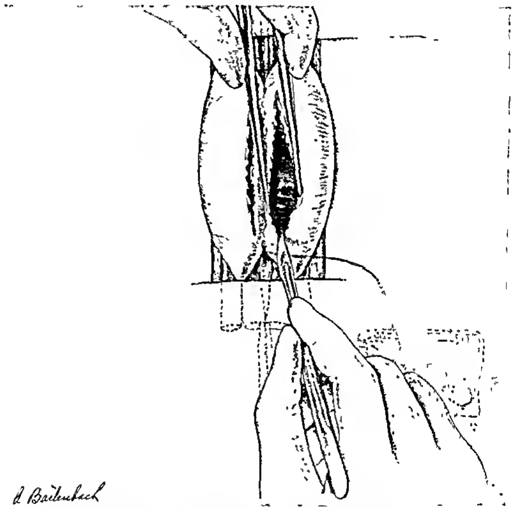

FIG 87. Lateral intestinal anastomosis. Cutting the mucosa by a knife in a downward direction. The tissue forceps prevents the knife from injuring the posterior wall.

while making the incision on the left loop (Fig. 85). These incisions should run parallel to the seromuscular line of suture and be at a distance of one-eighth of an inch from it. The incision should start one-fourth of an inch from one end of the suture-line, and should be continued until it reaches a point one-fourth of an inch from the other end of the line (Fig. 85).

The mucosa is now cut at the lower angle with the knife (Fig 86, A), and the incision is extended upward with scissors throughout the entire length of the exposed mucosa (Fig 86, B) If, however, it is necessary to cut the mucosa downward, it should be done with a knife (Fig 87) [The reason for cutting downward with the knife is that the surgeon can do this

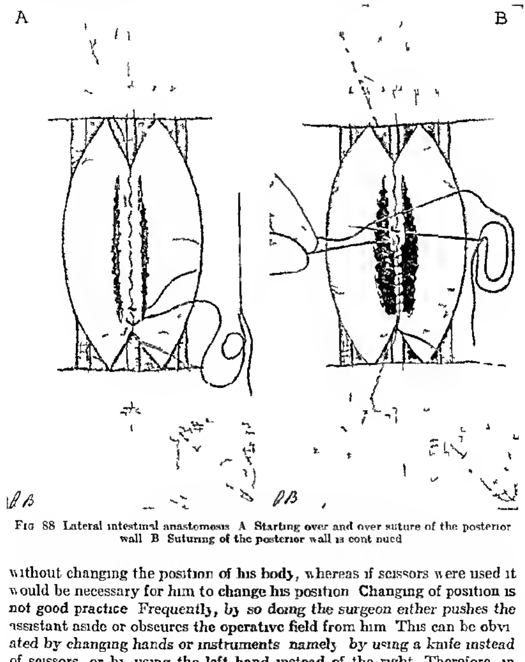

FIG 88 Lateral intestinal anastomosis A Starting over and over suture of the posterior wall B Suturing of the posterior wall is continued

without changing the position of his body, whereas if scissors were used it would be necessary for him to change his position Changing of position is not good practice *Frequently, by so doing the surgeon either pushes the assistant aside or obscures the operative field from him This can be obviated by changing hands or instruments namely by using a knife instead* of scissors, or by using the left hand instead of the right Therefore, in

order to cut the anterior wall of the intestine below the point where the bowel is opened, a knife should be used.]

In order not to cut too deeply, a tissue-forceps should be introduced into the lumen of the bowel and only the anterior wall cut (Fig. 87). Both loops should be opened to the same length.

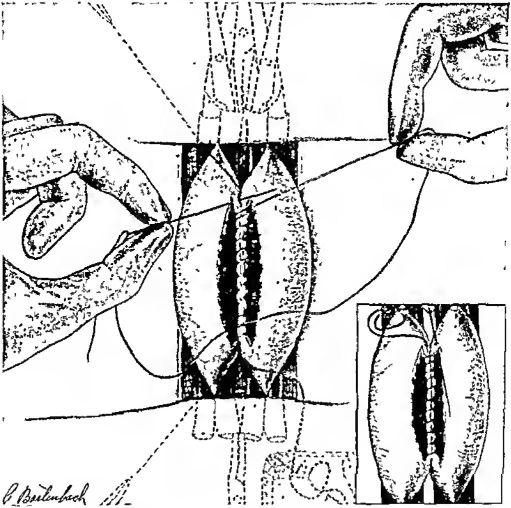

Fig. 89. Lateral intestinal anastomosis. Closing the angles of the incision.

Step 5. An over-and-over suture is started at the end of the bowel closest to the surgeon, the needle piercing both inner walls as close to the angles of the bowel as possible. Then the inner lip of the left loop is pierced from within outward. This is done with the left band. The inner lip of the right loop is then pierced from without inward. This is done with the right hand (*Fig. 88, A*). *The two ends of the thread are then tied*, and the knot will be within the lumen of the bowel. The free end of the thread

is clamped and covered by the towel (Fig 88, B) [No instruments should lie uncovered by a towel] The over and over suture is then carried through the entire thickness of the intestinal wall, locking each third stitch (Fig 88, B) As soon as the upper angle is reached, the inner lip is pierced from within outward (Fig 89, main picture) Then the needle pierces the lip of

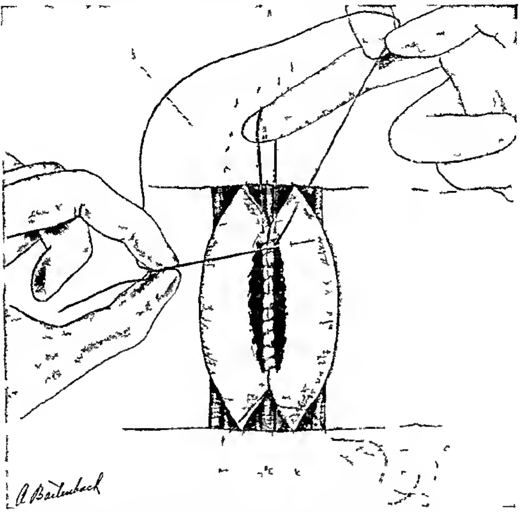

Fig 90 Lateral intestinal anastomosis The intestinal loop is pierced from within outward with the left hand

the opposite side from without inward (Fig 89, insert) The suturing is then continued in the form of a continuous Connell suture or as an over-and-over suture

The Connell suture has been described elsewhere as an interrupted stitch It will now be described in detail, as a continuous suture When the needle and thread are within the bowel, the needle pierces the lip

from within outward (Fig. 90). It then crosses the wound and pierces the *lip of the opposite side from without inward* (Fig. 91), and then the same lip from within outward (Fig. 92), so that loops are formed which are resting on the mucosa. In order not to use tissue-forceps for holding the edges of the wound, which would unnecessarily traumatize them, the thread is used

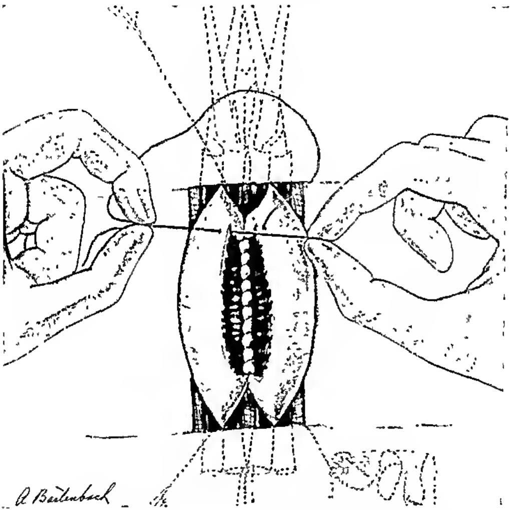

Fig. 91. Lateral intestinal anastomosis. The loop on the left side is pierced from without inward by the left hand and the needle is grasped by the right hand.

as a tissue-forceps (Figs. 90, 92). One hand should not be used continually for this suturing, since that would require a constant change of the position of the surgeon's body. The hands should be changed; passing from without inward the left hand should be used for the left loop (Fig. 91) and the right hand for the right (Fig. 89, insert); passing from within outward the reverse is true, namely, the right hand for the left loop (Fig. 92) and the

left hand for the right loop (Fig 90) In order not to lose time by taking the needle from one lip with one hand and inserting it with the other hand, *it should be caught with the hand which will make the next movement* Thus, in piercing the left lip from without inward the left hand should be used and the needle grasped with the right hand (Fig 91)

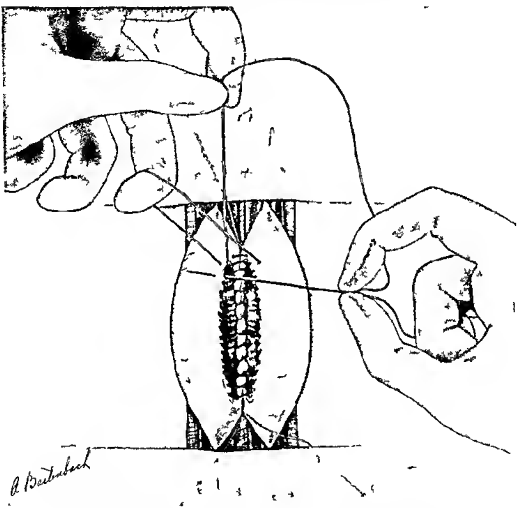

Fig 92 Lateral intestinal anastomosis The thread is used as a tissue forceps The loop of *the left side is pierced from within outward with the right hand*

Let us recapitulate In piercing the right loop from without inward the right hand is used But the needle is drawn out with the left hand, and then pierces the lip from within outward with this hand The needle is grasped with the left hand and penetrates the wall of the left loop (with the left hand) from without inward The needle is caught with the right hand and penetrates the wall of the left loop from within outward with the same

hand), and so on. This can be given mnemonically in the following way: **On passing the needle from without inward the hands should be changed; on passing from within outward, they should not be changed.**

When the anterior lips are sutured, the thread is tied to the end which was left long when the over-and-over suture began (Fig. 93). The ends are

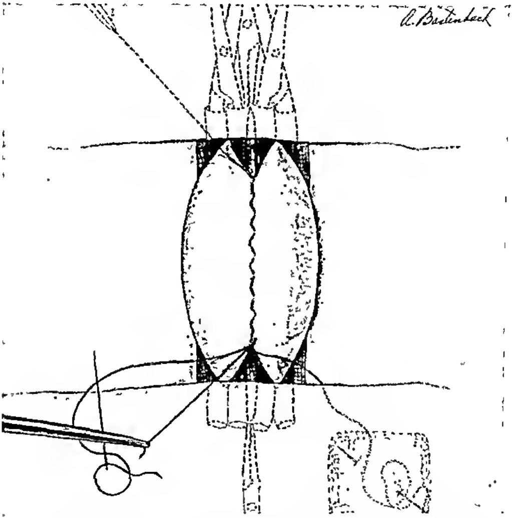

FIG. 93. Lateral intestinal anastomosis. The suturing of the anterior wall is completed and the ends of the thread are tied to each other.

then cut short. In this way, the thread and the knot will cut through the edge of the lip. However, this is of no importance, since this will take place only in from four to five days by which time the seromuscular layer, which is a reinforcing layer, will be strong enough.

Step 6. The clamps are unlocked and left in place with wide-opened blades so that the anastomosed loops rest on the central blades (Fig. 94).

The sponge which was placed behind the clamps is removed, and the ends of the blades are covered by a towel in order that the thread shall not be caught in them. The needle with the thread left after completion of the first row of the seromuscular suture then continues the Cushing seromuscular suture, moving away from the surgeon to the assistant. The right

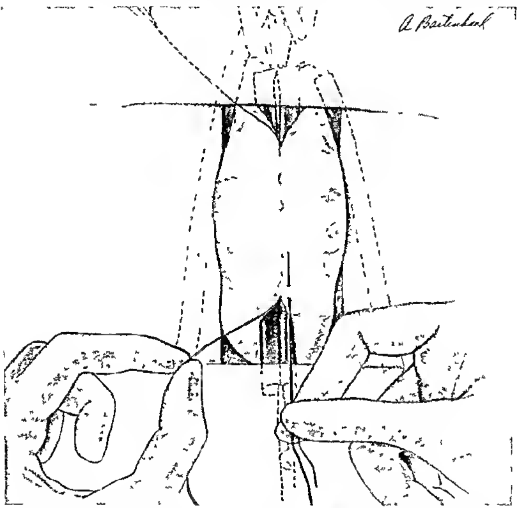

FIG 94 Lateral intestinal anastomosis The clamps are released, the seromuscular suturing is made with the right hand on the right side

hand is used for sewing the right loop (Fig. 94) and the left hand for the left loop (Fig. 95), and the needle is grasped with the hand with which the surgeon is going to make the next move. This suturing is continued in the described manner until the end of the incision on the assistant's side is reached. The thread on the needle is tied with the clamped thread on the assistant's side, and the ends are cut short (Fig 95, ins).

ALTERNATE METHOD OF SUTURING THE SEROMUSCULAR LAYER

Step 6. The clamps are loosened from the bowel. The sponge behind the clamps is removed, and the anastomosed loops are placed on the *palmar surface of the middle finger of the left hand.* With the index- and fourth fingers of this hand the anastomosed loops are immobilized (Fig.

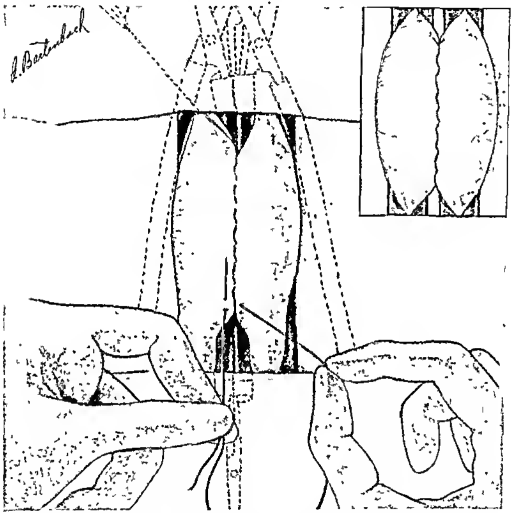

Fig 95. Lateral intestinal anastomosis. The clamps are released, the seromuscular suturing is made with the left hand on the left side.

96). The hand is then turned in the opposite direction (Fig. 97), and with *the needle left after completion of the first row of the seromuscular suture* the suturing of the seromuscular layer is continued toward the surgeon. When this line is completed, the thread is tied to the end of the thread left at the beginning of the operation.

As may he seen from this description the walls of the bowel are stitched

in two layers. The outer is seromuscular and, therefore, is aseptic. The inner is an over-and-over suture, which is contaminated. However, this contaminated inner layer is surrounded on all sides by the aseptic seromus.ular layer.

In the case of lateral intestinal anastomosis, the Connell suture may

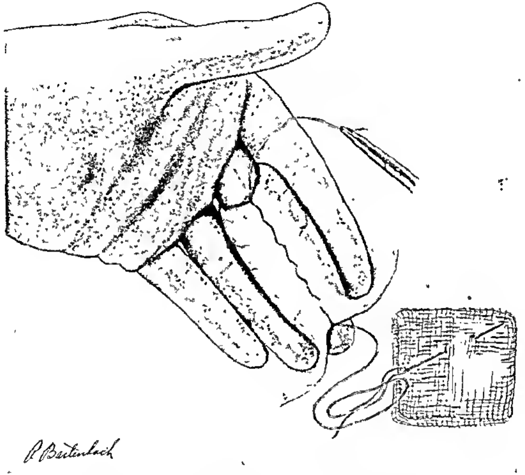

FIG. 96. Lateral intestinal anastomosis. Alternate method of suturing the anterior wall (See text).

be used advantageously. In the case of lateral anastomosis between the stomach and a loop of small bowel, however, it is better to use an over-and-over (glover) suture instead of the Connell suture. The reason for this is that in the Connell suture the edges of the wound are inverted, and if the wound bleeds, it will bleed inside and the surgeon will not know about it. In the case of an over-and-over suture the edges are everted, and if

bleeding occurs it would be outside and, being detected, can easily be checked.

Instead of using a Cushing right-angle suture for a seromuscular-seromuscular suture, we may use a continuous seromuscular-seromuscular suture (continuous Wysler suture). The operation is essentially the same

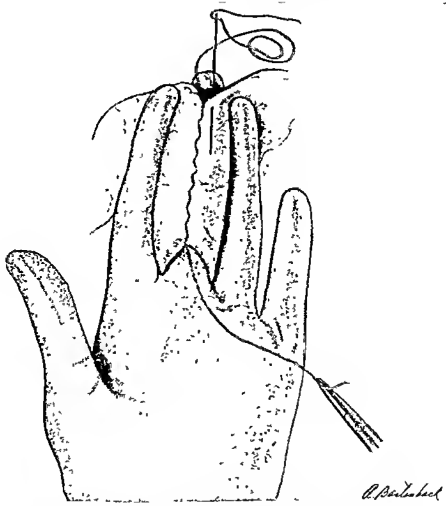

FIG. 97. Lateral intestinal anastomosis. Alternate method of suturing the anterior wall (See text).

as previously described in lateral intestinal anastomosis, with variations in some steps:

LATERAL INTESTINAL ANASTOMOSIS WITH CONTINUOUS (WYSLER'S) SEROMUSCULAR SUTURE

This is performed in a manner similar to that described in the previous operation, with this difference only that a continuous seromuscular suture

of the Wysler type is used instead of the Cushing suture at the beginning and at the end of the operation (Fig. 98).

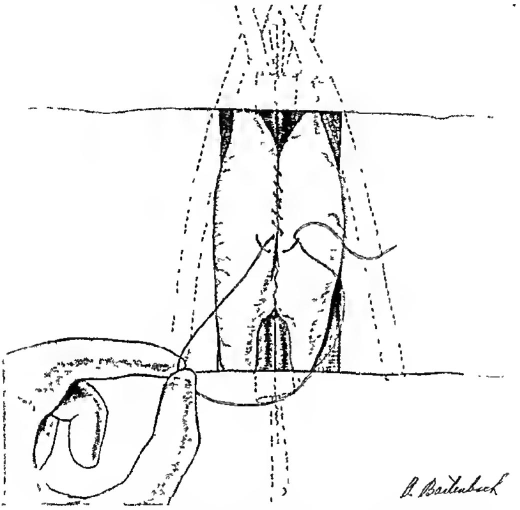

Fig 98 Lateral intestinal anastomosis Seromuscular suturing by the Wysler (Dupuytren) suture

II LATERAL INTESTINAL ANASTOMOSIS WITH THE AID OF A MURPHY BUTTON

As has already been mentioned, mechanical devices, such as the Murphy button, the Jaboulay button, or Harrington's segmented ring are seldom used. However, the Murphy button is occasionally used today, and for this reason we include here the description of the technic.

Step 1. A fold of bowel-wall, three inches in length, is grasped axially by an intestinal clamp in such a way that at least one and one-half inches of the bowel-wall lie free above the blade. The same is done with another loop of bowel.

Step 2. A seromuscular incision one inch long is made on each bowel (Fig. 99, insert).

Step 3. A purse-string suture is made around each seromuscular incision (Fig. 99, *insert*). The exposed mucosa of each loop of the bowel is cut

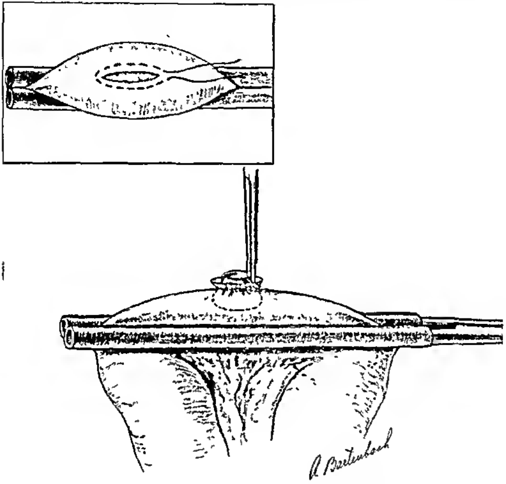

FIG. 99 Lateral intestinal anastomosis by the Murphy button.

through, and the male half of a Murphy button is introduced into one loop and the female half into the other loop (Figs. 99 and 100). The ends of the thread are tightly tied in the furrow of each half of the button and cut short. [When introducing the halves of the button into the lumen of the bowel they should be held by an artery-forceps which catches the tubular projection of each. Otherwise, they will slip, and it will be difficult to hold them while tying the purse-string.] As soon as the halves of the button are fastened, they are brought together and the male half is inserted

into the female In this manner the serous coverings will come into close approximation (Fig 101) When the part of the wall caught between the halves of the button sloughs away the button will become loose and will be expelled per rectum

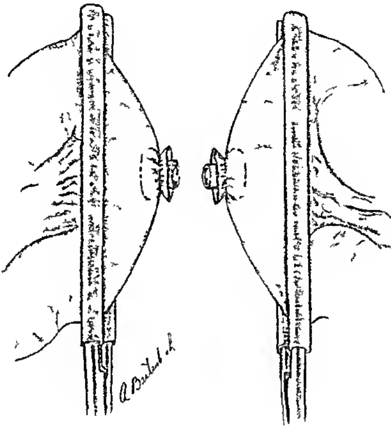

FIG 100 Lateral intestinal anastomosis by the Murphy button Each half of the button is inserted

There are some complications which may arise when performing intestinal anastomosis with the Murphy button

1 The efficiency of the anastomosis, that is, the "water tightness" of it, is just as much in the hands of the instrument maker as in those of the surgeon

2 Occasionally the parts of the wall caught in the button do not slough away, and the button may remain permanently fixed in the loop,

producing great narrowing of its lumen, and finally even an intestinal obstruction.

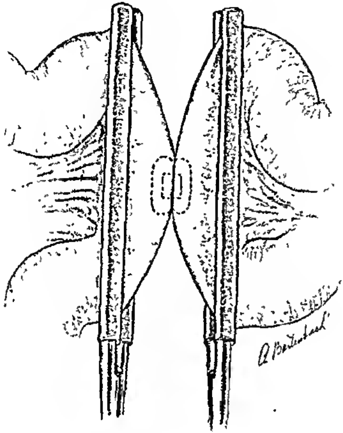

FIG. 101. Lateral intestinal anastomosis by the Murphy button. The halves of the button are clamped together.

B. RESECTION OF A BOWEL WITH END-TO-END INTESTINAL ANASTOMOSIS

End-to-end intestinal anastomosis is used as one of the methods of restoring the continuity of the intestinal tract after removal of a portion of a bowel. It was first suggested by Littré, in 1711, and was first performed by Ramdohr, court surgeon of the Duke of Braunschweig. He invaginated the proximal into the distal loop. The dangerous feature of invagination lay in the fact, that at that time the differentiation between the proximal and distal ends of the bowel was not known. This knowledge is absolutely

essential in performing the invagination method of anastomosis, since the distal loop must always be the recipient loop Duverger, in 1739, was the first who made an end to-end anastomosis by suturing the edges of all the layers of each loop He did this over the trachea of a lamb in the form of the "four masters suture"

Indications

Chief among these are

1 Gangrene of the bowel due to strangulation in a hernial sac

2 Multiple stab wounds or gunshot wounds of a bowel, when contemplated repair in several places will produce constriction of the bowel to such an extent that the passage of the intestinal contents will become difficult

3 Stricture of a bowel due to previous ulcerations which are healed

4 Malignant changes in the bowel

5 Irreducible intussusception of a bowel

6 Tumor or injuries of the mesentery involving the blood supply of the bowel

Schede proved that enterectomy and end to-end anastomosis should not necessarily be immediately consecutive steps of the operation It might happen that before the operation the loop of the bowel situated proximally to the place of obstruction, becomes greatly distended and inflamed Should an end to-end anastomosis then be performed immediately after resection of the contricted portion, the distended portion contracts and there may result marked tension on the suture line with yielding of some of the stitches resulting in leakage and peritonitis

How Much of the Intestines can be Removed?

As the length of the bowel varies in different individuals, it is clear than the quantity which can be removed will vary with the case This can be stated relatively to the whole length of the bowel only Beneke, after comparing the height of an individual and the length of his small bowel in a series of cases, stated that for every 100 cm of body length there are about 387 5 cm of small bowel Experiments on dogs and observations of patients have shown that about half of the length of the small bowel can be removed safely It is immaterial whether this will be the upper half or the lower half, though from the physiological point of view, we should expect that the removal of the upper half will lead to more serious consequences than the removal of the lower half

The age is a very important factor in determining this question Relatively more can be removed from a young person than from an old one,

since in the former the vicarious ability of the remaining part is greater than in an adult. Thus, in Ruggi's case, 330 cm. (10 ft. 10 in.) were removed successfully from a boy eight years old. The largest piece of bowel removed from a human being successfully was on a patient, reported by Brenner, when 540 cm. (17 ft. 10 in.) of small bowel were removed.

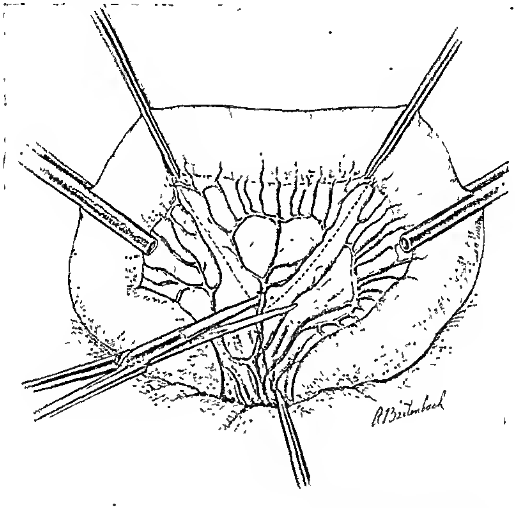

FIG. 102 End-to-end anastomosis by the suture method. The mesenteric artery and the arcuate vessels are tied; scissors ready to cut the mesentery between the two ligatures.

End-to-end anastomosis may be performed:

I. By *suture methods*
II. By mechanical devices.

I. END-TO-END ANASTOMOSIS BY THE SUTURE METHOD

Step 1. The loop of the bowel which is to be resected is drawn out and

crushing-clamps are placed on each end of this loop (Fig. 102); the clamps should be placed obliquely so that more of the bowel-wall on the mesenteric border will be left. The reason for this is twofold: 1. It widens the lumen, so that a stricture will not follow after completion of the anastomosis. 2. The blood-supply to the free border of the bowel is better assured in this way.

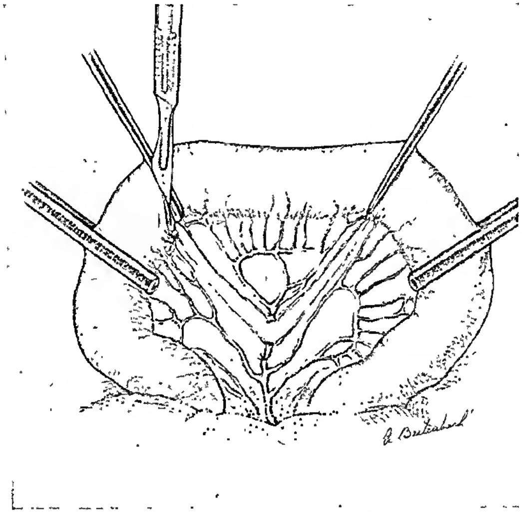

Fig. 103. End-to-end anastomosis by the suture method. The mesentery is cut in a V-shape; the knife begins to cut the bowel.

Step 2. From the point where each crushing-clamp is placed the intestinal contents are "milked out" for two inches. On each side of the clamp at a distance of two inches from each crushing-clamp an intestinal clamp covered with rubber tubing is placed (Fig. 102). The operative field is walled off from the peritoneal cavity by towels soaked in normal salt-solution.

Step 3. The mesenteric vessels which furnish the blood-supply to the bowel to be resected are ligated by two ligatures and cut between (Fig. 102). The arcuate artery on the side of each crushing-clamp is ligated between this clamp and the intestinal clamp close to each crushing-clamp. This should be done with a round curved intestinal needle, care being taken

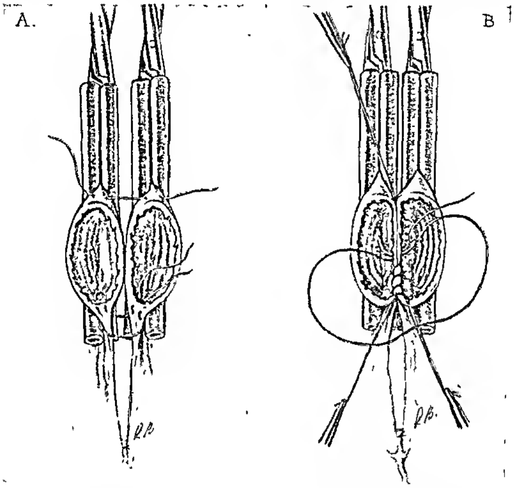

FIG. 104. End-to-end anastomosis by the suture method. A. Maunsell mesenteric stitch inserted; guy stitch is inserted on the free border of the bowel; B. Suturing the posterior wall by an over-and-over suture.

to catch also the seromuscular layer of the adjoining intestinal wall (Fig. 102).

Step 4. The mesentery is cut in a V-shape, the apex of which is the stump left after ligation of the mesenteric vessels. Then only should the bowel be cut by the knife just lateral to each crushing-forceps (Fig. 103).

Step 5. Suturing of the ends of the bowel is begun, using for this purpose

Maunsell's mesenteric stitch (Fig 104, A), the ends of the thread being left long and grasped by an artery forceps, so that they may be used as a traction suture Another traction suture is placed on the free (antimesenteric) border of the bowel This suture penetrates the seromuscular layer only (Fig 104, A), and is placed close to the edge of the open end of the

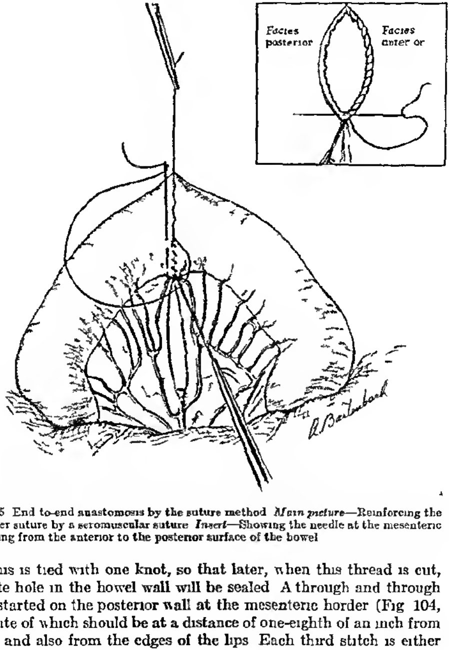

Fig 105 End to-end anastomosis by the suture method *Main picture*—Reinforcing the over and-over suture by a seromuscular suture *Insert*—Showing the needle at the mesenteric border passing from the anterior to the posterior surface of the bowel

bowel This is tied with one knot, so that later, when this thread is cut, the minute hole in the bowel wall will be sealed A through and through suture is started on the posterior wall at the mesenteric border (Fig 104, B) each bite of which should be at a distance of one-eighth of an inch from the other and also from the edges of the lips Each third stitch is either locked or a back stitch is made When the second traction suture is

reached, it should be left intact and the suture is continued either in the form of a Connell suture or as an over-and-over suture until the mesenteric border again is reached. The thread attached to the needle is tied with the *thread left long at the beginning of the* suture and the ends are cut short.

Step 6. The over-and-over suture is now reinforced by a seromuscular

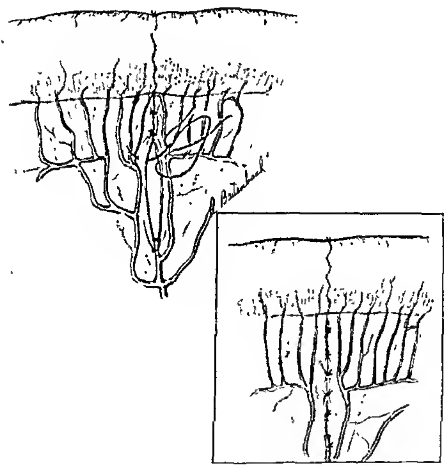

FIG 106 End-to-end anastomosis by the suture method Closure of the opening in the mesentery.

suture which starts from the antimesenteric border. The ends of the thread which were on the antimesenteric border and which have been used as a traction-suture are now cut short. The seromuscular suture continues in the form of a Cushing right-angle continuous suture (Fig. 105), so as not to produce a diaphragm. When the mesenteric border is reached, the needle is passed to the other side of the bowel by penetrating the mesen-

tery very close to the wall of the bowel (Fig. 105, insert), which is then turned so as to make the posterior wall face anteriorly [this can be accomplished by drawing the traction-suture applied to the mesenteric border through the hole in the mesentery, and by drawing the end of the thread of the seromuscular suture on the free border in the opposite direction]. A continuous right-angle Cushing suture, or a continuous Wysler suture, is continued, making a back-stitch after each third stitch, until the free border of the bowel is reached. Then the beginning and the end of this seromuscular suture are tied together and cut short. The ends of the thread of the Maunsell mesenteric stitch are also now cut short. The bowel is replaced in its proper position so that the anterior wall faces anteriorly and the posterior wall posteriorly.

Step 7. The slit in the mesentery is closed by a continuous suture or by interrupted sutures (Fig. 106), care being taken not to injure any blood-vessel lying close to the edge of the mesenteric wound.

II. END-TO-END ANASTOMOSIS BY A MECHANICAL DEVICE (MURPHY BUTTON)

Step 1. The same as Step 1 of the previous operation.

Step 2. The same as Step 2 of the previous operation.

Step 3. A purse-string suture is made one-half inch away from each crushing-clamp.

Step 4. The same as Steps 3 and 4 of the previous operation.

Step 5. The male half of the button is introduced into one open end of the bowel, its tubal projection being held by an artery-forceps while tying the ends of the purse-string. The female half of the button is then introduced into the open end of the other loop in the same manner. The male tube is inserted into the female (Fig. 107).

Step 6. The line of anastomosis is reinforced by a few seromuscular stitches.

Step 7. An additional stitch is placed on the mesentery close to the button.

Step 8. The slit in the mesentery is closed as shown in Step 7 of the previous operation (Fig. 107, insert).

C. END-TO-SIDE INTESTINAL ANASTOMOSIS

Definition.

This is an implantation of an open end of a bowel into the lateral wall of another bowel.

Indications.

1. Most frequently it is used in cases of resection of the cecum or colon, as in an ileo-sigmoidostomy.
2. In colo-colostomy.

3. In the Roux "Y" method of gastro-enterostomy.
4. In Maydl's method of jejunostomy.

This operation can be performed either by the suture method or with the aid of some mechanical device such as the Murpby button.

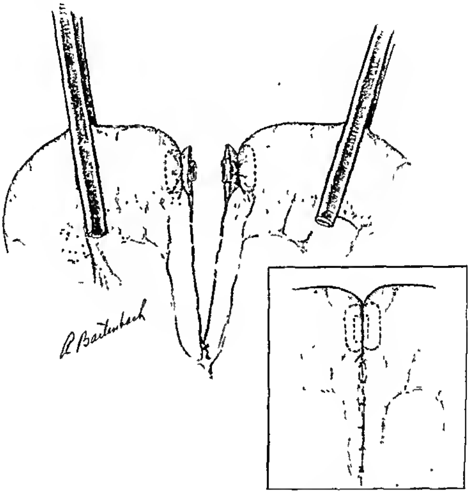

FIG. 107. End-to-end anastomosis by the Murphy button.

We will now describe an end-to-side anastomosis between two loops of small bowel, leaving implantation of an end of a small bowel into the lateral wall of a large bowel to be described in the Chapter on "The Surgery of the Large Bowel."

I. END-TO-SIDE ANASTOMOSIS BY THE SUTURE METHOD

1. Gould Method.

Step 1. A loop of small bowel is grasped and the intestinal contents are

"milked out" for a length of six inches Three intestinal clamps, the blades of each covered with rubber tubing are placed, one at one end of the "milked out" gut, another at the other end, and the third between the other two, in such a manner that it will be two inches away from the

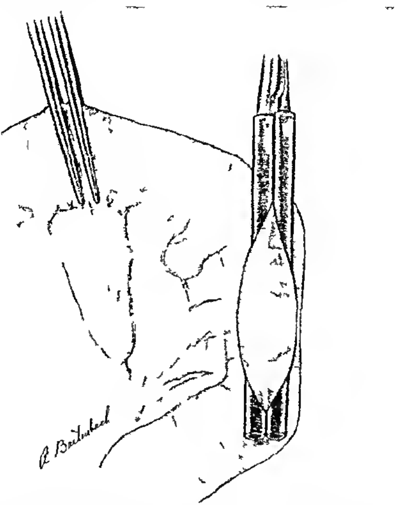

FIG 108 End to-side anastomosis by the suture method The bowel is clamped between two forceps a fold of bowel is clamped axially (See text Alternate Method of End to-side Anastomosis)

clamp on the proximal end and four inches away from the clamp on the distal end of the gut The middle clamp is placed obliquely

Step 2 The arcuate vessels are ligated at two points close to the middle clamp and between it and the proximal clamp and the jejunum is divided, the incision passing between the two ligated arcuate vessels Then the proximal part will be left open with one clamp at a distance of two inches from its open end, and the distal loop will be held by two intestinal clamps

Step 3. The free border of the proximal segment is cut longitudinally for one-half to one inch and the sharp edges so produced are trimmed. In this way, the lumen of the bowel will be increased.

Step 4. The receiving bowel is opened for one and one-half inches on its free border.

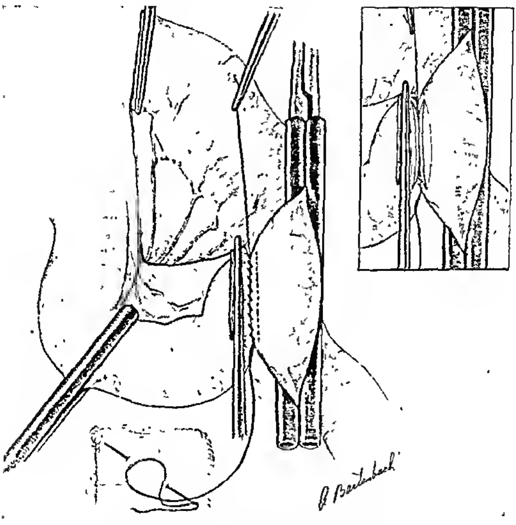

Fig. 109. End-to-side anastomosis by the suture method. (See text: Alternate Method of End-to-side Anastomosis.)

Step 5. The proximal loop of the divided bowel is brought to the lateral wall of the distal loop so that the mesenteric border lies at the lower angle (which means that the mesentery will face upward). The lower end of the incision is attached to the mesenteric border of the entering bowel by a mattress-suture. A guy-stitch is placed on each side of this mattress-suture with the free ends lying inside the lumen of each bowel. Each of these

threads penetrates the middle of the lip of the entering and receiving bowel The edges will thereby be everted and the suturing facilitated The over-and over suturing is done in the usual way, this layer being reinforced by a second layer of Lembert sutures (interrupted)

Step 6 The lip of the mesentery is sutured either to the wall of the

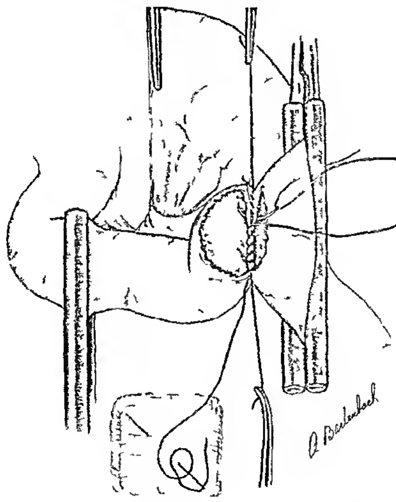

Fig 110 End to-side anastomosis by the suture method Suturing of the posterior wall (See text Alternate Method of End to-side Anastomosis)

jejunum, to the mesojejunum, or to the posterior abdominal wall (if this be possible) This is done to prevent the occurrence of internal strangulation

Step 7 The open end of the distal loop of the bowel may be closed blindly, brought outside, or implanted into another hollow viscus, this depending on the reason for which the operation has been done

2. Alternate Method of End-to-side Anastomosis.

Step 1. Two crushing-clamps are placed closely together and obliquely upon a loop of bowel, and this loop and its mesentery are cut between the clamps remembering, however, to cut first the mesentery and then the bowel (Fig. 108).

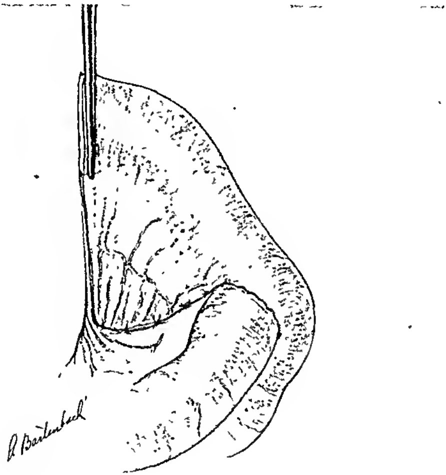

FIG. 111. End-to-side anastomosis by the suture method. The mesentery of the entering bowel is sutured to the mesentery of the receiving bowel.

Step 2. A longitudinal fold of the recipient bowel is grasped by an intestinal clamp. The entering loop of bowel is then brought to this fold *in such a way that its mesentery faces upward (Fig. 109). A seromuscular* suture is made between these two loops (Fig. 109), and after this is completed the last stitch is locked, and the threaded needle is placed on a piece of gauze beneath the towel.

Step 3. The contents of the entering loop are "milked out" for a dis-

tance of three inches, and an intestinal clamp is applied transversely to its long axis, and locked tightly enough to prevent escape of the intestinal contents but not enough to interfere with the blood supply (Fig 109)

Step 4 A seromuscular incision is made on the recipient loop of the bowel and also on the entering loop of the bowel just below the clamp The seromuscular layer will begin to curl and cover the seromuscular line of suture, so that when the lumen of the bowel is opened this suture will not be contaminated (Fig 109 right upper insert)

Step 5 The mucosa of both loops is incised, thus opening the lumina of these loops (Fig 110)

Step 6 The operation is now completed as described in the technic of a lateral intestinal anastomosis starting with that step in which the over-and over sutures are to be placed (Fig 110)

Step 7 The edge of the mesentery of the divided loop of bowel is sutured to the mesentery of the recipient loop, thus preventing a possible strangulation of the bowel (Fig 111)

II END TO SIDE ANASTOMOSIS BY MECHANICAL DEVICES (MURPHY BUTTON)

Step 1 An intestinal loop is "milked out" for a distance of six inches One intestinal forceps clamps the proximal end perpendicularly to its axis, another grasps the distal portion of the gut axially, and a third midway between grasps the gut perpendicularly to its axis

Step 2 The arcuate vessels are ligated in two places close to the middle clamp and between it and the proximal clamp A purse string suture is placed proximally around the intestinal loop one half inch away from the middle intestinal clamp

Step 3 A seromuscular incision one inch long is made on the fold held axially by the distal intestinal clamp A purse string suture is made around this incision

Step 4 The bowel is cut obliquely between the middle and proximal intestinal clamps in such a manner that the plane of the incision passes between the ligated arcuate vessels

Step 5 The male half of the Murphy button is introduced into the open end of the proximal loop and fixed in the same manner as already described (Fig 112)

Step 6 The mucosa of the antimesenteric border of the distal loop is incised and the female half of the button introduced and fixed exactly as described in the side to side anastomosis by the Murphy button The male half of the button is then inserted into the female half (Figs 112, 113) The site of union is reinforced by a seromuscular suture

Step 7 The edges of the mesentery are sutured either to the wall of the recipient bowel or to its mesentery or to the peritoneum of the posterior wall (Fig 113)

Step 8. The open end of the distal bowel may be treated according to the aim of the operation.

BLIND CLOSURE OF AN OPEN END OF A BOWEL

This procedure is an essential step in several operations. Thus, it is a routine step in gastrectomies of the type of Billroth II and its modifications.

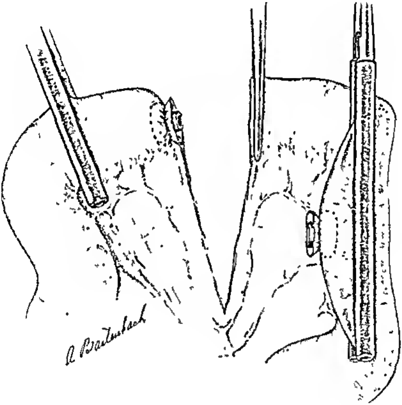

FIG. 112. End-to-side anastomosis by the Murphy button.

It is also used as one of the steps in what is known as the "Haberer-Finney Modification of Billroth I." It might be used in cases of enterectomies when, after resection of a loop of bowel, the continuity is reestablished by a lateral intestinal anastomosis between the remaining parts of the bowel after blind closure of the end of each loop. There are different methods of performing this:

a. Over-and-over suture method
b. Purse-string method

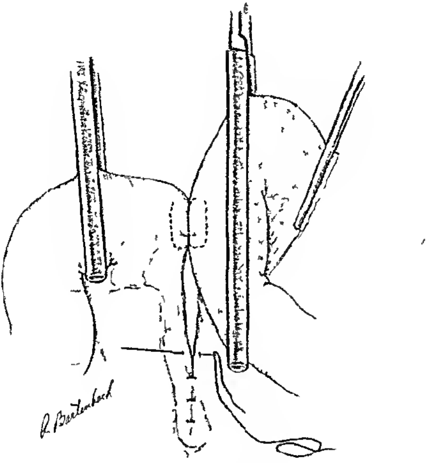

FIG 113 End to-side anastomosis by the Murphy button The end of the divided piece of bowel is inserted into the side of the other loop of bowel Suturing of the mesenteric edges to each other

a BLIND CLOSURE BY THE OVER-AND-OVER SUTURE METHOD

Step 1. After the bowel is cut between two crushing-clamps, the closure of either or both of these ends is accomplished in the following manner: A *seromuscular suture starts from the antimesenteric border of the bowel,* the first bite being placed at the distance of one-half inch from the lower border of the blade of the clamp and directed toward it (Fig 114, A). The thread is carried over the clamp with each successive stitch until the mesenteric border is reached [In order to make the side of the bowel on which

the surgeon is going to take a bite visible to him, the assistant should turn the clamp each time thereby exposing the sides of the bowel alternately (Fig. 114, B).] Each bite is taken close to the clamp and parallel to it, the last bite being one-half inch from the clamp on the mesenteric border and directed away from it (Fig. 114, C).

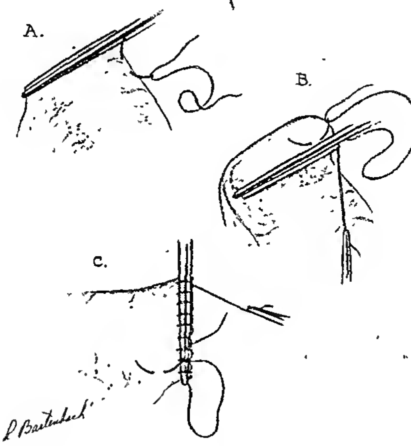

Fig. 114. Blind closure of an open end of bowel. A. Starting the suturing at the antimesenteric border; B. Turning the clamp in order to expose the side on which the suture is to be inserted; C. Inserting the last stitch.

Step 2. The assistant holds both ends of the thread. The surgeon holds the bowel between the index-finger and the thumb of his left hand one and one-half inches away from the clamp (Fig. 115). With the right hand he takes the handles of the crushing-clamp and gently opens it so that the opened blades shall not tear the thread. The blades are then closed again, and pressing with the tips of the clamp on the crushed end of the bowel, he

slowly draws out the clamp while the assistant is pulling the ends of the thread apart (Fig 115) By this maneuvre the end of the bowel will become invaginated

Step 3 With the needle left on the thread, the seromuscular suture is continued in a direction opposite to the direction of the first layer (Fig

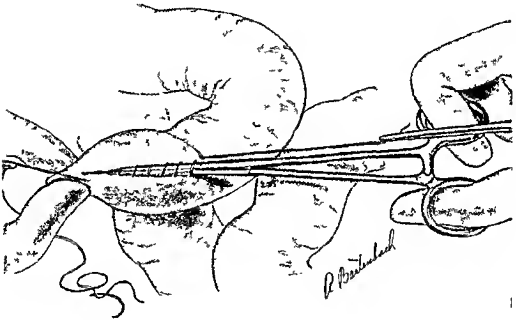

Fig 115 Blind closure of an open end of bowel Invaginating the end of the bowel

116, A) until the beginning of this suture is reached (Fig 116, B), when the ends of the thread are tied

b BLIND CLOSURE BY THE PURSE-STRING METHOD

Step 1 A crushing-clamp is applied to the bowel which is then cut through flush with the blade

Step 2 A purse string seromuscular suture is inserted about one-half

inch away from the clamp. The bowel is held in the left hand and the clamp removed by the right hand. The end of the bowel is invaginated as described above, and the assistant ties the ends.

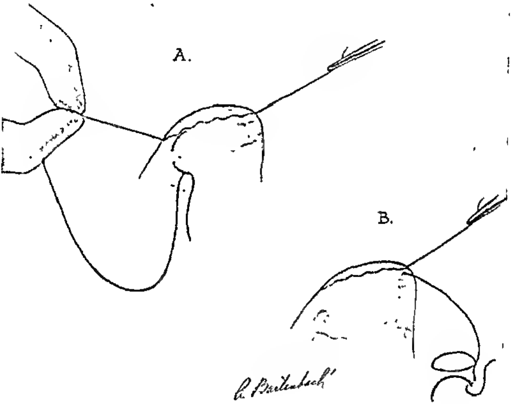

FIG. 116 Blind closure of an open end of bowel. A. Starting the second row of sutures; B. The second row completed.

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CHAPTER VI

ENTEROTOMY. ENTEROSTOMY

ENTEROTOMY

Definition.

The word enterotomy consists of two Greek words: ἔντερον, bowel and τομή, a cut. It means to make an opening in the bowel which is closed at the same sitting of the operation.

Indications.

a. Removal of foreign bodies.
b. As a step in operations for obstructed bowel.

Technic.

The technic varies somewhat, depending on whether the operation is done for the removal of a foreign body or as a step in an operation for intestinal obstruction.

ENTEROTOMY FOR REMOVAL OF A FOREIGN BODY

Step 1. The loop of bowel on which it is intended to make the incision is grasped and two intestinal clamps, the blades of which are covered with tubing, are placed at a right angle to the long axis of the bowel, one proximally to and the other distally from the intended line of incision. The gut is walled off from the peritoneal cavity by gauze-packs, moistened in warm, normal salt-solution.

Step 2. A longitudinal incision is made along the free border of the bowel, the length of which depends upon the size of the foreign body.

Step 3. The foreign body is dislodged and removed.

Step 4. The incision is closed in the following manner: Three over-and-over sutures are inserted. One passing through the upper and lower angles of the incision, the second, passing through adjoining points of the middle of the left lip, and the third passing through adjoining points of the middle of the right lip. The ends of the threads are tied and left long so that they can be used as traction-sutures. The lips of the wound between the traction-sutures are united by over-and-over sutures. When this is done, the ends of the traction-sutures and the ends of the over-and-over sutures are cut short. This layer is reinforced by a second layer of seromuscular sutures in the usual way. Thus, the bowel, cut longitudinally, is sutured transversely, thereby preventing a narrowing of its lumen.

ENTEROTOMY AS A STEP IN INTESTINAL OBSTRUCTION

Enterotomy until recently had been looked upon as an essential step in the treatment of acute intestinal obstruction. With the introduction of decompressing procedures, such as Wangensteen suction method, enterotomy is not often indicated for evacuation of the toxic intestinal

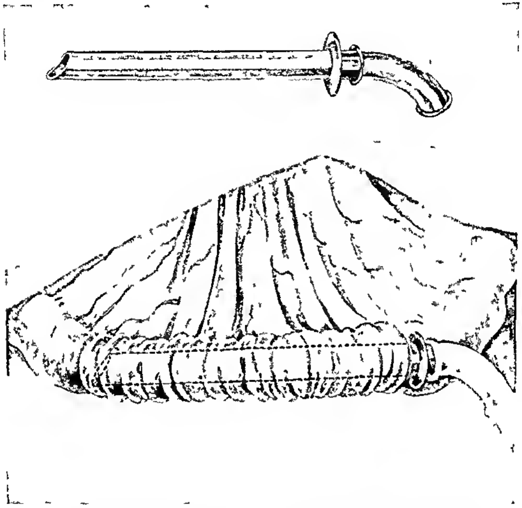

FIG 117. Enterotomy Plaiting the bowel over a glass tube (after Moynihan)

contents. However, in some cases we may be forced to do it. The technic then is the following:

Step 1. The abdomen is opened.

Step 2. The bowel which is ensnared is located and freed. It is then brought out of the abdominal cavity and "walled off" from the peritoneal cavity by moist packings. The assistant compresses the wall of the bowel in two places. one about ten inches above the site of the former constric-

tion, and the other immediately below this point. He should do this, not with gloved fingers, because the bowel is extremely difficult to hold and will slip away, but with a piece of moistened gauze, which will give stability to the gut.

Step 3. The wall of the bowel is caught on each side of the antimesenteric border by two French vulsellæ about five inches above the seat of the former obstruction. Care must be taken that it is caught in the healthy portion of the gut.

Step 4. The free border of the bowel is opened between the two vulsellæ.

Step 5. A glass tube, the length of which is from six to eight inches, to the other end of which a large rubber drainage tube is attached, is introduced into the lumen of the bowel and pushed in the proximal direction for three or four inches. The vulsellæ are then removed from the lips. The bowel, held by a piece of gauze moistened with warm normal salt-solution, is drawn upon the glass tube until it nearly reaches the outer end of the tube. This should be done with wet warm gauze, which will prevent the fingers from slipping. Thereby there will be no leakage of intestinal contents between the glass tube and the lips of the bowel. The surgeon draws more and more of the bowel on this glass tube (Fig. 117). [Monks showed that on a tube of six inches in length, eight or ten feet of bowel can be drawn.] While pleating the bowel on the tube the intestinal contents will empty through the glass and rubber tubes. This manipulation should be done very slowly.

[N.B. The reason for this pleating is that by making a mere opening in the bowel the contents of only one or two of the immediate proximal loops will escape. The rest will remain in the more remote proximal loops. By pleating the intestinal wall on the glass rod, the contents of many loops will escape.]

Step 6. The bowel is then unpleated from the tube. This is done very slowly. As soon as the bowel is all drawn back into the abdomen, the glass tube is slowly withdrawn from the lumen of the bowel. The assistant tightly holds the opening into the bowel.

Step 7. The incision into the bowel is closed as described in Step 4 of the previous operation, or in the form of a linear suture which corresponds to the long axis of the bowel.

ENTEROSTOMY

Definition.

Enterostomy consists of two Greek words: *ἔντερον*, bowel and *στόμα*, mouth. It is a surgical procedure by which the lumen of the bowel is opened and remains in communication with the outside world. If it is performed in such a manner that it closes later spontaneously, it is called

temporary enterostomy If it does not close spontaneously but requires a special operation for its closure, then it will be a permanent enterostomy Depending on the portion of the bowel which is opened, enterostomy is subdivided into duodenostomy, jejunostomy, ileostomy, appendicostomy, cecostomy and colostomy, the name itself implying where the opening is made Depending on the portion of the bowel which is opened, enterostomy may serve either as an artificial mouth for feeding the patient (upper jejunostomy) or as an artificial anus (lower ileostomy or colostomy) In this chapter will be described only the different types of jejunostomy or ileostomy The colostomy operations will be given in Chapter VIII, "Surgery of the Large Bowel"

Indications

A *As an Artificial Anus* This is done

1 In some cases of malignant or benign stricture of the cecum, when for some reason, the cecum cannot be removed at the time of operation

2 In case of obstruction in the lower ileum or cecum, when the strangulation or incarceration cannot be removed at the time of operation, and the surgeon is compelled to be satisfied with releasing "back pressure" by making a "temporary artificial anus"

B As an Artificial Mouth (for feeding purposes) This is done

1 In case of carcinoma of the pylorus when pylorectomy or gastroenterostomy for some reason cannot be performed

2 In case of ulcer of the stomach when the surgeon wants to cure the ulcers by the "Rest Method" (Von Eiselsberg, Lameris, etc)

3 As a preliminary step in certain operations on the stomach or esophagus

A ENTEROSTOMY (ILEOSTOMY) FOR AN ARTIFICIAL ANUS TEMPORARY ENTEROSTOMY IN TWO STAGES

First Stage

Step 1 The site of the opening of the abdomen depends upon the location of the loop in which enterostomy is to be made Thus, for a high jejunostomy, the incision should be made in the left upper quadrant [in case a transverse incision is desired it should be made at the level of the umbilicus and directed transversely through the left rectus muscle] In case of a low ileostomy, the incision should be made in the right lower quadrant [In case the transverse incision is preferred, it should be made transversely through the right rectus muscle at a level midway between the umbilicus and the symphysis pubis]

Step 2 The selected loop is brought out of the abdominal cavity and is anchored at the upper and lower ends of the incision by one suture at each angle These sutures penetrate the peritoneum and transversalis

fascia about one inch from their margin, then pass through the seromuscular layer of the bowel-wall, and then again pass through the transversalis fascia and peritoneum of the other lip, also at a distance of one inch from its margin (Fig. 118, a).

Step 3. The peritoneum is sutured to the seromuscular layer of the

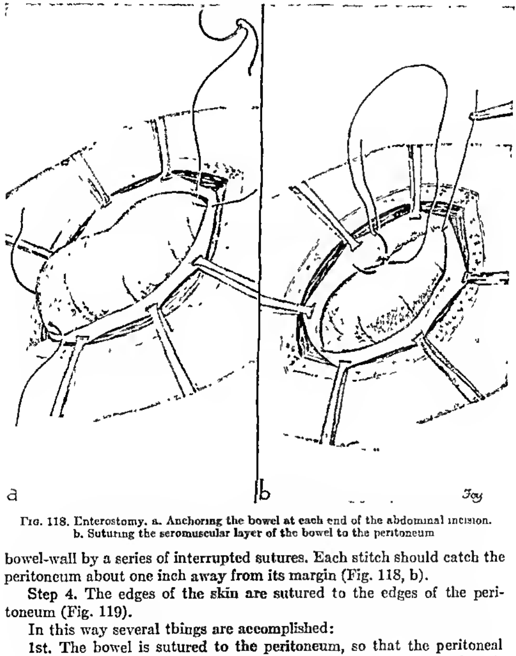

FIG. 118. Enterostomy. a. Anchoring the bowel at each end of the abdominal incision. b. Suturing the seromuscular layer of the bowel to the peritoneum

bowel-wall by a series of interrupted sutures. Each stitch should catch the peritoneum about one inch away from its margin (Fig. 118, b).

Step 4. The edges of the skin are sutured to the edges of the peritoneum (Fig. 119).

In this way several things are accomplished:

1st. The bowel is sutured to the peritoneum, so that the peritoneal cavity is shut off from the site of the contemplated opening into the bowel.

2nd. The skin is sutured to the peritoneum, which will prevent the intestinal contents from entering and contaminating the layers of the abdominal wall.

3rd. There will be no bowel spur-formation, which means that spontaneous closure will be greatly facilitated when the need for enterostomy is over.

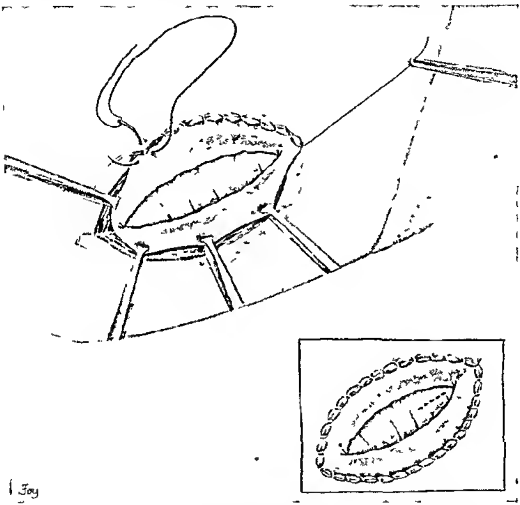

FIG 119 Enterostomy Suturing the edges of the skin and peritoneum to each other. *Insert*—Opening of the bowel

Second Stage.

Step 5. *One or two days later the bowel is opened by a longitudinal or* transverse incision (Fig. 119, insert).

If, however, it is necessary to open the bowel immediately, then the procedure will be as follows: A purse-string suture is placed in the bowel, and the sero-muscular layer of the loop is incised within the purse-string

until the mucosa bulges. The protruding mucosa is caught by an Allis forceps and the cone of mucosa thus produced is cut with scissors. A glass tube is immediately inserted into the opening and the ends of the thread are tied snugly around it.

We have described this technic rather in detail, since it is quite frequently used by surgeons both for ileostomy and colostomy. However, we always prefer to attach the loop of bowel (ileum, sigmoid) to the skin in such a manner, that no sutures pass through the wall of the bowel, as is described below:

Step 1. The abdomen is opened in the right lower quadrant or by a lower midline incision. The length of the incision should be three to four inches.

Step 2. Any distended loop of ileum is selected, preferably one closest to the site of the obstruction, and it is brought out of the abdominal cavity until its mesentery reaches the skin-surface. It must be determined which is the proximal and which the distal end of the loop.

Step 3. A bite is taken through the entire thickness of the inner lip of the anterior abdominal wall, including the skin. Then, the needle passes through some avascular spot in the mesentery close to the mesenteric border of the gut, and then penetrates the outer lip of the abdominal wall through its entire thickness from within outward (*Fig. 146, b*). It then returns through the mesentery very close to the spot where the first perforation of the mesentery was made (Fig. 146, c). Thus, a loop is formed on the outer lip with the free ends of the thread lying on the inner lip. A piece of rubber tubing is placed on each lip so that the one on the outer lip will lie inside the loop and that on the inner lip will lie between the ends of the thread, which are then tied (Fig. 146, d).

Step 4. If it is possible to wait for two or three days, the proximal portion of the bowel is then cut either transversely (cutting approximately two-thirds of its circumference) or longitudinally, starting from the proximal portion and reaching nearly to the apex of the gut. If, however, there is no time to wait, then Step 4 will be as follows:

Step 4. A purse-string is made on the free border of the bowel. The *seromuscular layer is incised within this purse-string*. The exposed mucosa is caught by an Allis forceps and cut with scissors. A glass tube is inserted and the ends of the purse-string tied tightly.

B. ENTEROSTOMY (JEJUNOSTOMY) FOR AN ARTIFICIAL MOUTH

From the physiological point of view, the best procedure would be a duodenostomy, since then the food would be brought in contact with the bile and pancreatic juice close to the point where these secretions pour in from the ampulla of Vater. However, the duodenum should never be used for this purpose, since the unavoidable escape of the duodenal contents

onto the skin, with the resulting eczema of the skin, outweigh the advantages of introducing the food close to the stomach

Jejunostomy (of the proximal jejunal loop) should always be given preference to duodenostomy The first who performed jejunostomy was Surmay, in 1878 A few methods of performing jejunostomy are given here

I SPIVACK S METHOD OF TUBO VALVULAR JEJUNOSTOMY

In this method a tube and a valve at its base are formed from that portion of the jejunal wall which constitutes and adjoins the antimesenteric border The tube is lined with mucosa and for this reason its lumen will not obliterate, the valve will enter the lumen of the tube and stay at its base, it will prevent escape of the intestinal contents outside Thus, the two difficulties which usually confront the surgeon in this type of operation, namely leakage and obliteration of the channel, are eliminated The steps of this operation are the same as in the Spivack's tubo valvular *gastrostomy*

II WITZEL-KAREWSKI METHOD OF JEJUNOSTOMY

This operation, in which the technic Witzel used for gastrostomy was applied to the jejunum, was first performed by Karewski in 1896

Step 1 The abdomen is opened in the left half of the epigastric region Whether this incision is longitudinal or transverse depends on the choice of the operator In case the incision is longitudinal, it should be a left paramedian In case it is transverse, it should be a left transverse rectus incision at a level one inch above the umbilicus Its length in either case is *three inches*

Step 2 The duodeno jejunal junction is located by the method of Wolfler Socin, and the first loop of the jejunum is brought out Beginning at a distance of eight inches from the duodeno jejunal junction, the contents of the jejunum are "milked out" for a distance of some inches, and an intestinal clamp is placed at each end of the "milked out" area perpendicularly to the long axis of the bowel

Step 3 A catheter, size number 12 French, is laid on the wall of the jejunum A series of interrupted seromuscular sutures are inserted in the bowel wall over the catheter for a length of three inches (Fig 120, a) *All the threads, with the exception of that one lying close to the eye of the* catheter, are tied, thus forming a channel which surrounds the catheter (Fig 120, b) The wall of the bowel is now incised and the eye-end of the catheter is inserted into the lumen of the bowel, after which the last untied suture is tied, thus closing the opening in the bowel

Step 4 The bowel is anchored to the peritoneum in two places, one immediately distal to the distal end of the channel and the other immediately proximal to the proximal end of the channel (Fig 120, b, asterisks),

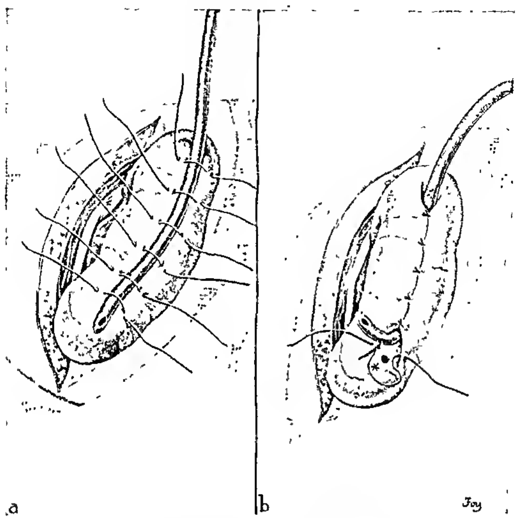

FIG 120. Witzel-Karewski method of jejunostomy.

these sutures penetrate the seromuscular layer of the bowel and the peritoneum with the transversalis fascia of the abdomen.

Step 5. The abdomen is closed.

III. MAYDL METHOD OF JEJUNOSTOMY (FIG. 121, a, b)

Step 1. An abdominal incision is made as in the previous operation.

Step 2. A loop of jejunum six inches from the duodeno-jejunal junction is drawn out, and one intestinal clamp, the blades of which are covered with rubber tubing, is placed across it about six inches distally from the duodeno-jejunal junction, and another clamp in the same manner about twelve inches from this junction. The clamps are placed perpendicularly to the long axis of the gut, which they compress just enough to prevent the escape of intestinal contents but not enough to interfere with the blood-supply. The arcuate vessels are ligated at two points, the distance between these points being about one-eighth of an inch. The place of ligation of

tbe arcuate vessels is about three inches distal from the proximal clamps. The bowel is cut obliquely, so that the line of incision runs between the ligated arcuate vessels.

Step 3. The proximal end of the bowel is implanted into the antimesenteric horder of the distal loop in such a manner that there will still he

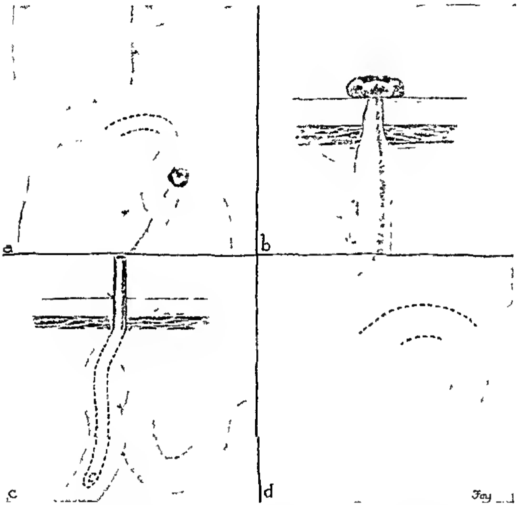

Fig 121 Jejunostomy a–b Maydl method, c–d Mayo Robson method

left ahout three inches of the distal end of the jejunum, which should be anchored to the anterior abdominal wall (Fig 121, a, b). The technic of implantation is exactly as described in end-to-side anastomosis.

Step 4. The jejunal tube is anchored separately to each layer of the anterior abdominal wall, that is to the peritoneum and transversalis fasc a, to the muscles, to the anterior sheath of the rectus muscle, and to the skin. [For a detailed description of anchoring a tube to the anterior abdominal wall see Spivack's tubo-valvular gastrostomy].

IV. MAYO ROBSON METHOD OF JEJUNOSTOMY (Fig. 121, c, d)

Step 1. The abdomen is opened in the left upper quadrant and a loop of jejunum is drawn out as close to the duodeno-jejunal junction as possible, but without any tension. A lateral intestinal anastomosis is made between the two limbs placed in an antiperistaltic direction (Fig. 121, c). The technic of the lateral intestinal anastomosis is exactly the same as described in "Lateral Intestinal Anastomosis."

Step 2. A seromuscular incision is made on the knuckle of the loop and a purse-string is made around it. The mucosa is incised, and a catheter is introduced and fastened to the bowel. Care must be taken that the catheter placed into the lumen reaches into the efferent loop beyond the point of anastomosis of the two loops (Fig. 121, c).

Step 3. The bowel is anchored to the peritoneum at two places close to the catheter. The abdomen is closed by tier-suturing.

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CHAPTER VII

ASEPTIC METHODS IN GASTRO-INTESTINAL SURGERY

The great number of methods employed in gastro intestinal surgery and known as "aseptic methods" are not aseptic in the true meaning of this word In order to be aseptic, the lumen of the hollow viscus should not be entered It is true that there are methods in which the lumen of a hollow viscus is not entered, but these methods are highly impractical and are not employed today The methods which are in use are those in which the lumen is entered, but the contamination is negligible, and for such methods the name "aseptic methods" is retained

Historical

One of the earliest methods of "aseptic anastomosis" is the "elastic ligature" method It was introduced by Silvestri, in 1862, but was soon forgotten Bardenheuer, in 1888, revived interest in this method, and McGraw, who more than anybody else popularized and improved the method, described it only in 1891 His technic was as follows

A seromuscular suture two and a half inches long is made connecting the walls of the two hollow viscera A seromuscular incision is made on each of the two viscera at a distance of one quarter of an inch from the sero muscular suture line An elastic ligature, threaded on a special needle, penetrates the mucosa of one hollow viscus close to one end of the sero muscular incision, enters into the lumen of the same viscus and reappears outside of the lumen at the other end of the incision of the same viscus It then enters into the lumen of the other viscus at a point close to its exit from the first viscus, traverses the lumen of the second viscus and makes its exit at a point close to the point of entrance of the ligature into the first viscus The two ends are drawn very tight and tied The original sero muscular suture is continued over the elastic ligature uniting the anterior lips of the seromuscular incision, and this completes the operation

Usually, due to pressure-necrosis the mucous membrane will slough away, and thus the anastomosis will be established The elastic ligature will pass *per vias naturales* As may be seen, the weak points of this operation are

1 It is not truly aseptic, because the ligature enters into the lumen of the intestine (or stomach)

2 Necrosis of the mucosa will not always take place, and thus the anastomosis may not be established

The Postnikow method was as follows A seromuscular suture was made connecting the two hollow viscera and a seromuscular incision was

made on both viscera at a distance of one-quarter of an inch from the suture-line. The mucosa of each viscus was caught with a forceps and drawn out in the form of a cone and tied tightly at its base. The original seromuscular suture was continued to cover the muscosa. As may be seen, this method is truly aseptic, since the lumina of the viscera were not entered. However, the results of the anastomosis were uncertain.

The Boari method was similar to that of Postnikow with the difference only that, instead of tying the mucosa, caustic material was placed on it, which produced necrosis of the mucosa and thereby established the anastomosis. The same objections which were raised *in the case of the* Postnikow method hold true in this method.

An important step forward in the development of a "relatively aseptic method" was the discovery by Halsted that the true strength of the union is given by the submucous layer. This means that a really strong union can be secured not only by taking a bite through the entire thickness of the wall of the viscus, but also when the bite includes the entire wall with the exception of the mucosa. The knowledge of this fact enabled the surgeons to place sutures not entering the lumen and before the viscus was opened, and then to tie the opening as soon as it was made, thus greatly diminishing the possibility of contamination. In this manner, Winiwarter and Halsted performed lateral intestinal anastomosis. Bircher, gastro-enterostomy, and Finney, gastro-duodenostomy. *Acting upon the same principle*, Parlavecchio did his resection of the bowel with the reëstablishment of its continuity by an end-to-end anastomosis, and Axel Werelius his lateral intestinal anastomosis.

THE PARLAVECCHIO END-TO-END ANASTOMOSIS

The portion of the bowel to be resected was tied at each end by two ligatures and the bowel cut at each end between the ligatures. The ends of the remaining portions of the bowel were sutured to each other by a series of interrupted seromuscular stitches placed laterally from each ligature, until nearly the entire circumference was sutured. Through the small opening which was still left the ligature which closed each end of the bowel was cut, and the small rent left in the circumference was closed by one or two additional interrupted seromuscular sutures.

This method had, however, several objectionable features:

1. The possibility of contamination was not excluded.
2. A large diaphragm was left which could produce an obstruction, or at least a marked narrowing of the lumen.
3. There was a possibility of hemorrhage.

THE WERELIUS METHOD OF LATERAL INTESTINAL ANASTOMOSIS

Step 1. A seromuscular suture connected the walls of the two hollow viscera.

Step 2 A silk thread or silver wire, penetrating the entire thickness of the wall, was placed exactly as in the case of the McGraw elastic ligature entering the lumina of both viscera

Step 3 The original seromuscular suture was continued anteriorly to cover the silk or silver ligature, leaving only a very small opening through which these ligatures emerged

Step 4 By sawing movements the walls of the two hollow viscera were broken and the thread released

Step 5 The small opening was closed by a seromuscular suture

The objections to this method were

1 The *possibility of hemorrhage*
2 Breaking of the thread
3 The possibility of sawing off the posterior seromuscular suture line
4 The method still made contamination possible

Bonomo modified the Werelius method His technic was that of Werelius with the difference only that after making the first seromuscular suture line he made a seromuscular incision on the wall of each viscus and then introduced a silk thread or silver wire through the mucosa only, completing the operation as Werelius did In this way, it was easier to saw off the mucosa only instead of the entire thickness of the anterior stomach or bowel wall The large blood vessels exposed by the seromuscular incision could also be ligated before the introduction of the silk or silver suture, thereby preventing the probability of hemorrhage

The next important step in the development of aseptic intestinal anastomosis was the method suggested by Doyen He introduced a powerful enterotribe which crushed the wall of the bowel to the thinness of tissue paper Of the entire thickness of the intestinal wall only the serosa and submucosa were left in the form of thin lamellæ The blood-vessels were crushed so that there was no danger of hemorrhage

His technic for the resection of the bowel was as follows The bowel was crushed at two places by an enterotribe, which was then removed The groove produced by the enterotribe was tied between two ligatures on each side and the bowel was cut between each of these ligatures In this way the bowel was resected The ends of the bowel were brought together by an end to-end approximation, and a seromuscular row of sutures was introduced in almost the entire circumference, leaving a very small opening through which scissors were introduced to cut the lamella on each side including the ligature The rent in the seromuscular union was closed by introducing two additional seromuscular sutures In this way, the anastomosis was reestablished, there was no hemorrhage and very little contamination

Parlavecchio made a further technical improvement (Fig 122) Two crushing clamps were placed at each end of the bowel, and the latter cut

by the cautery between the clamps. The ends of the bowel to be anastomosed were brought together so that the clamps lay side by side. A series of interrupted seromuscular sutures were placed over the clamps first on the posterior surface and then on the anterior surface. The clamps were removed and the sutures tied. Thus, we can see, that the crushed wall

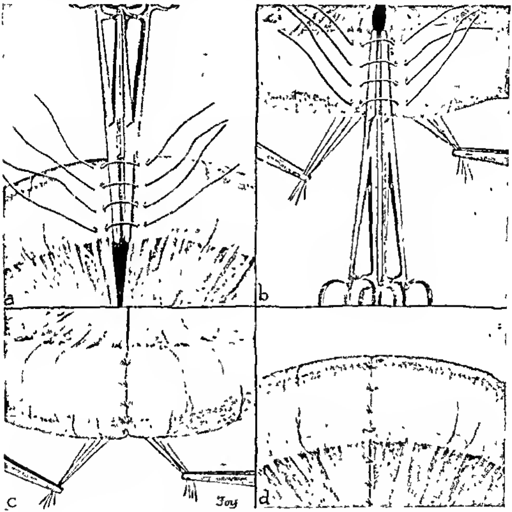

FIG. 122. Aseptic intestinal anastomosis by the Parlavecchio method.

would not bleed, and the agglutinated ends would prevent the escape of the intestinal contents while the ends of the ligatures were tied. As may be seen, in this operation both Halsted's and Doyen's principles were utilized. A similar procedure was done about the same time by M. O'Hara.

Another prominent festure in the Parlavecchio method was that the ends were divided by the cautery, which actually sterilized the intestinal contents which might lie on the surface of the blades.

Rostowzew, of Petrograd, greatly popularized the "aseptic intestinal suture" In its essence, his method was practically as was outlined by Parlavecchio, with a few slight technical modifications

A very popular method in Germany and Austria was that of Moszkowicz, which was a still further technical improvement of the Parlavecchio and Rostowzew methods

Thus, we may say, that the main factors on which are based the possibility of aseptic intestinal suturing are

1 The submucous layer is the main holding layer in gastro intestinal union (Halsted) From the practical point, it means that a strong union between two viscera can be established without entering into the lumen of a hollow viscus

2 Crushing clamps by crushing the wall also crush the blood vessels, thus obviating the danger of hemorrhage (Doyen)

3 Cutting by a cautery renders the field "relatively aseptic"

On these three principles is based the entire structure of all modern "aseptic methods" in intestinal suturing

As is clear from the above description, the mucosa is never sutured to the mucosa This is of no importance in the suture of bowel to bowel and is by far outweighed by the aseptic features of the operation However, in surgery of the stomach the reverse is true The danger, due to contamination is not great, but the complications which may arise from not suturing the mucous layer of the stomach to the mucosa of the other viscus (particularly peptic gastro-jejunal ulcer) are very grave, and for this reason we believe that the closed aseptic methods should never be employed when one of the viscera is the stomach, and that aseptic methods should be reserved only for intestinal work, and especially for the surgery of the large bowel

We now describe a few accepted methods of end to end end to side and lateral intestinal anastomosis as now employed Some of these methods are convenient when special enterotribes are not available However, if the operation is pre arranged we consider the work with the Doyen enterotribe or the Rankin or Partipilo clamp much preferable

END TO END ANASTOMOSIS WITH PRELIMINARY BLIND CLOSURE OF THE ENDS OF THE BOWEL (PARKER KERR METHOD)

Step 1 A crushing clamp is placed on each end of the bowel to be resected These clamps are placed obliquely (approximately at 30°), in such a manner that the mesenteric border becomes most prominent This will secure a better blood supply and will make the lumen larger Another clamp is placed to the inner side of each of the previously placed clamps The arcuate vessels are ligated, and the bowel is cut on each side between each pair of clamps

Step 2. Each end of the bowel is closed by a *basting-suture, the ends* of which are left untied. The technic of making a basting-suture was described in Chapter V. [N.B. It must be clearly understood that the word "basting," taken from the seamstress's language, presupposes a loosely placed temporary suture which can easily be removed.]

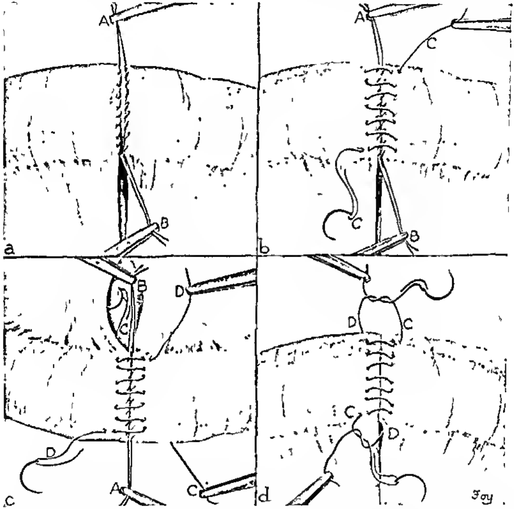

Fig. 123. End-to-end anastomosis by the Parker-Kerr method a Each end of the bowel is closed temporarily by a basting-suture and the ends are brought together; b. Seromuscular suturing of the anterior surfaces of the bowel; c. Seromuscular suturing of the posterior surfaces of the bowel; d Basting-sutures withdrawn; tying the ends of the permanent sutures to each other

Step 3. The closed ends of the bowel are brought together, the assistant holding with one hand the beginning sutures and with the other the terminating sutures of each bowel (Fig. 123, a). A continuous seromuscular suture is *made on the anterior wall of each end of the bowel* (Fig. 123, b) and then another seromuscular suture is made on the posterior surface

(Fig 123, c) The two basting sutures are then withdrawn and the ends of the permanent threads are tied to each other (Fig 123, d) A second seromuscular suture reinforces the first one

Step 4 With a finger placed on the wall of either bowel the partially agglutinated ends are broken through, so as to restore the continuity at the place of anastomosis

Step 5 The rent in the mesentery is closed

A side to-side and an end-to side anastomosis may be done by this method, as follows

LATERAL INTESTINAL ANASTOMOSIS (PARKER KERR METHOD)

Step 1 A fold of one bowel is grasped by a crushing forceps, and this fold is cauterized flush with the surface of the blades Closure of the bowel is made over the blades of the clamp by a basting suture

Step 2 Step 1 is repeated on another loop of bowel

Step 3 The two loops of bowel are placed side-by-side, and the assistant holds with one hand the beginning sutures and with the other hand the terminating sutures of each bowel A seromuscular continuous suture connecting the posterior surfaces of the two bowels is made, and then is continued on the anterior wall until the entire circumference is sutured Each third stitch is locked, or a back stitch is made so as to prevent a purse-string action The basting sutures are pulled out and the ends of the thread are tied to each other A second seromuscular suture reinforces the first

END TO SIDE ANASTOMOSIS (ILEO SIGMOIDOSTOMY) (PARKER KERR METHOD)

Step 1. The arcuate vessels of the terminal part of the ileum are ligated, and crushing clamps are placed obliquely at the site of the intended division The bowel is cut by the cautery

Step 2 Each end of the bowel is closed The distal end is closed permanently, and therefore should be reinforced by another seromuscular suture The proximal end is closed temporarily by a basting-suture

Step 3 A fold of the sigmoid is grasped in a crushing-clamp The size of the fold should be equal to the diameter of the proximal end of the ileum to be implanted into the sigmoid The protruding part of the sigmoid is "shaved off" by the cautery and sutured with a basting-suture

Step 4 The proximal end of the ileum and that portion of the sigmoid where the basting suture lies are brought end-to side A seromuscular suture is made, connecting the posterior walls of each, and this is continued anteriorly until the entire circumference is sutured Each third stitch is locked or a back stitch is made in order to prevent purse-string action The basting-sutures are pulled out and the ends of the seromuscu-

lar thread are tied to each other. A finger is introduced into the newly made anastomosis by invaginating the wall of the bowel.

Step 5. The rent in the mesentery is closed in the usual manner.

The method of Parker-Kerr accomplishes the anastomosis without any special intestinal clamps. An ordinary Kocher or Ochsner clamp, round

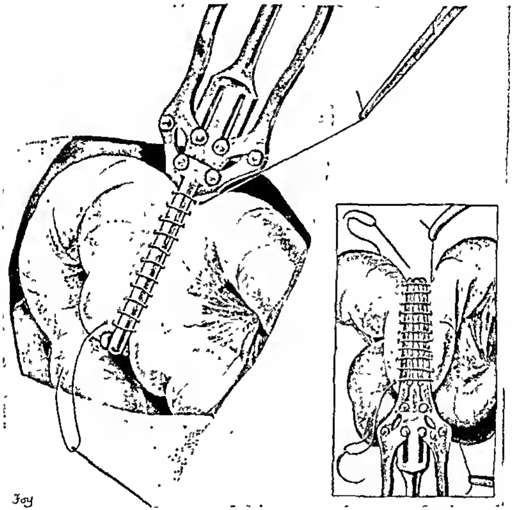

FIG. 124. Aseptic lateral intestinal anastomosis by the Rankin clamp.

needles and thread are all that is necessary. However if special enterotribes are at our disposal the work is much facilitated.

We shall present now an end-to-end, end-to-side, and a lateral anastomosis with the aid of the Partipilo or the Rankin clamp. All these procedures can be performed by either of the clamps. However, we shall demonstrate some of the operations with one and some with the other clamp so that the surgeon may familiarize himself with each of them.

LATERAL INTESTINAL ANASTOMOSIS WITH THE RANKIN CLAMP (Fig 124)

Step 1. *The two loops of the bowel to be united are grasped by the* blades of the Rankin clamp which are closed tightly The clamp is then turned so that its posterior surface faces anteriorly. A seromuscular suture is then started on this surface from the handles of the blades toward the tip (Fig 124) After completing the suture of the posterior surface, the clamp is turned back so that the anterior surface faces anteriorly

Step 2. The folds of the bowel projecting above the blades are "shaved off" by the cautery

Step 3 Another seromuscular suture is carried over the blades, beginning at their tip, until the other end of the "shaved off" portion is reached (Fig 124, insert). The assistant takes with one hand the two ends of the thread on one side and with the other hand the two ends on the other side The surgeon slightly separates the lateral blades from the middle one and then gently pulls out the forceps, depressing the tip, while the assistant pulls the ends in one hand away from those in the other hand This will bury the crushed part of the walls The ends of the thread on each side of the bowel are tied to each other with moderate firmness in order to prevent purse-string action and are cut short

Step 4. This seromuscular layer is reinforced by another layer of seromuscular sutures The agglutinated site of the anastomosis is broken by a finger, thus rendering the lumen patent

END TO END ANASTOMOSIS BY THE PARTIPILO CLAMP (Figs 125 126 127)

The contents of the bowel are "milked out," the mesenteric and the arcuate blood-vessels ligated and the mesentery cut in a "V"-shape as in the ordinary method of enterectomy described in Chapter V Then

Step 1. A Partipilo clamp grasps each end of the bowel in a direction perpendicular to its long axis, immediately lateral to the site of the contemplated line of incision [Care should be taken to see that the bowel at each end is grasped by the symmetrical portions of each clamp] (Fig 125) A strong Ochsner or a Payr clamp is placed medially and close to each Partipilo clamp, and the bowel is divided by the cautery between each Partipilo and Ochsner clamps Thus a portion of the bowel is resected

Step 2. Two Partipilo clamps are brought together and set so that the prongs of one clamp fit into the indentations of the other clamp and fastened by a screw Thus the two clamps of the Partipilo instrument become immobile as if they were parts of one instrument (Fig 126)

Step 3 The clamp is turned in such a manner that the posterior surface of the bowel faces anteriorly (Fig 126, a) A seromuscular suture starts at the point most remote from the tip of the blades and to the right of the surgeon and runs over the clamp until the point on the bowel closest

to the tip of the blade is reached. The last bite is made on the bowel lying to the left of the surgeon. The clamp is then turned to its original position so that the anterior surface of the bowel faces anteriorly. Another seromuscular suture is made over the blade, starting at the point closest to the tip of the blade and to the right of the surgeon. The last bite of this

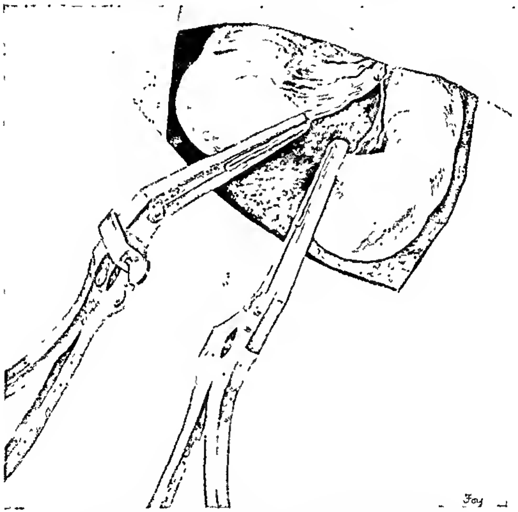

FIG. 125. Aseptic end-to-end intestinal anastomosis by the Partipilo clamp. Each half of the Partipilo clamp holds a divided end of the bowel.

continuous suture is made at the point of the bowel farthest from the tip of the blades and to the left from the surgeon. Thus, on each end of the bowel are present a thread on a needle and a thread clamped by an artery-forceps (Fig. 126, b).

Step 4. The surgeon grasps the two threads lying on his side of the bowel with his left hand. The assistant grasps the threads lying on his side. The surgeon now releases the lock of each part of the Partipilo clamp,

however not changing the mutual relationship of the parts of the clamp (Fig. 127). The clamps are now slowly withdrawn. While removing the clamp the assistant pulls his two threads away from the bowel. As soon as the clamp is removed, the surgeon pulls his two threads away from the bowel. The surgeon and the assistant tie the ends of the threads to

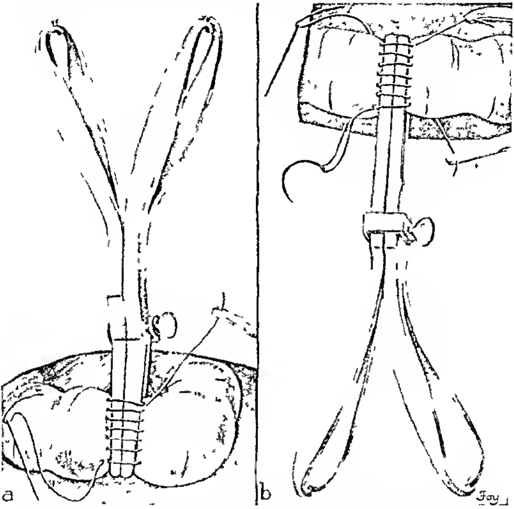

Fig 126 Aseptic end-to-end anastomosis by the Partipilo clamp a Seromuscular suturing of the posterior surfaces of the bowel, b Seromuscular suturing of the anterior surfaces of the bowel

each other with moderate firmness, so as to prevent the purse-string action of these threads. The ends are then cut short.

Step 5. The suture-line is reinforced by another seromuscular suture.

Step 6. The diaphragm thus produced is then broken by invaginating with the finger the wall of the bowel.

Step 7. The rent in the mesentery is closed in the usual manner.

END-TO-SIDE ANASTOMOSIS BY THE PARTIPILO CLAMP (ILEO-SIGMOIDOSTOMY)

Step 1. The Partipilo clamp is placed obliquely on the terminal portion of the ileum (at least six inches away from the ileo-cecal junction) in order to secure a larger lumen and a better blood-supply. Any crushing-

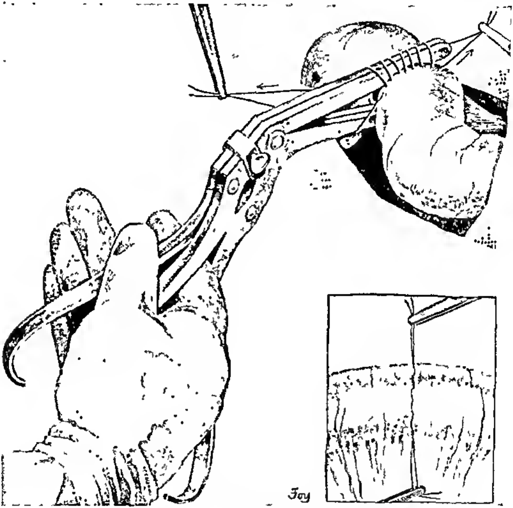

FIG 127. Aseptic end-to-end anastomosis by the Partipilo clamp
The clamp is unlocked and ready to be removed.

clamp (Kocher or Ochsner) is placed distally but very close to the Partipilo clamp. The bowel is cut by the cautery between the Kocher and the Partipilo clamps. The end of the ileum connected with the cecum is closed by the over-and-over suture method.

Step 2. *A fold of the free border of the sigmoid is grasped by the* other half of the Partipilo clamp and is cut by the cautery. The clamps are set as one unit by inserting the prongs into the indentations and are

fastened by the screw The compound Partipilo clamp is then turned so that the posterior surface faces anteriorly, and a seromuscular suture is inserted until the posterior half is united The clamp is then returned to its normal position and another seromuscular suture is made until the anterior half of the circumference is united

Step 3 The assistant takes with one hand the short end of one thread and the threaded on the needle end of the second thread and in the other hand the short end of the second thread and the threaded on the needle-end of the first thread The surgeon opens each half of the Partipilo clamp, not touching the screw so that the mutual relationship of the individual clamps of the compound Partipilo instrument is not altered The clamp is gently removed, depressing the tip of the blades, so that the crushed part is buried while the assistant pulls the threads in the opposite direction The short end is then tied to the threaded end on each end of the bowel with moderate force so as to prevent purse string action and the ends are cut short

Step 4 This seromuscular layer is reinforced by another layer of seromuscular suturing

Step 5 The rent in the mesentery is closed

Lateral intestinal anastomosis, end to-end anastomosis and end to side anastomosis can be done very conveniently by Furniss clamps or by any of its modifications This clamp has two blades with interdigitating teeth which when brought together, shirr the tissue between them Down the face of each blade is a groove approximately one half the pitch of the teeth This groove forms a channel when the jaws are approximated through which a pin may be thrust

END TO END ANASTOMOSIS BY THE FURNISS CLAMP

The contents of the bowel are "milked out" the mesenteric and the arcuate blood vessels ligated and the mesentery cut in a V shape as in the ordinary method of enterectomy described in Chapter V Then

Step 1 A Furniss clamp grasps two loops of the bowel in a direction perpendicular to its long axis, immediately lateral to the site of the contemplated line of incision A pin is inserted into the groove A strong Ochsner or a Payr clamp is placed above the Furniss clamp and the two loops of bowel are divided by the cautery between the Furniss and Ochsner clamp Thus a portion of the bowel is resected (Fig 127A, 1 and 2)

Step 2 The Furniss clamp is removed, leaving the gut shirred and pinned together (Fig 127A, 3)

Step 3 A seromuscular continuous suture line is made connecting the two loops of bowel over the needle This suture will invert the shirred surface This suture is continued on the other side of the junction of the two loops The pin is now removed (Fig 127A 4 and 5)

Step 4. A second seromuscular suture line reinforcing the first one is made in the manner described in Step 3.

Step 5. An interrupted seromuscular suture is placed at the mid-portion of each wall, leaving the ends long. These long ends will serve to break

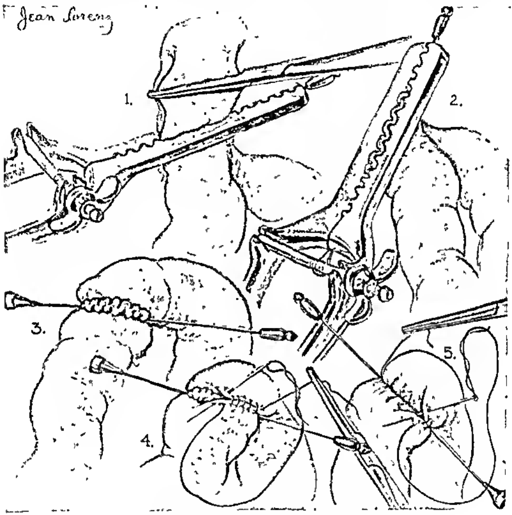

FIG. 127A. Resection of bowel by Furniss clamp.

the cohesion between the walls of the bowel and open the lumen. The threads are then cut short.

Step 6. The rent in the mesentery is closed.

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CHAPTER VIII

SURGERY OF THE LARGE BOWEL

I APPENDECTOMY

Definition

This word is composed of the Latin word **appendix**, which means "appendage," and the Greek suffix **ἐκτομή**, excision It signifies, "excision of the appendix" The term "appendicitis" was coined by Reginald Fitz in 1886

Indications

Any disease of the appendix requires its removal, since the diseased appendix may rupture and lead to fatal peritonitis, or it may act as a focus from which the disease may be carried to other abdominal or pelvic organs either by hematogenous or lymphogenous extension or by continuity of tissue

Anatomy.

The appendix takes its origin from the *posterior* and *medial surface* of the cecum, three-fourths of an inch below the ileo cecal junction, at the place where the three longitudinal tænia coli meet This point is quite constant From it the appendix may extend in different directions (Fig 128) The length of the appendix varies from one-fourth of an inch to twelve inches, its average length being three inches However, cases of hypoplasia of the appendix are described in which its length was only one-twelfth of an inch In such cases, it becomes extremely difficult to recognize whether or not we are dealing with the appendix The most common position of the appendix is given below in the order of decreased frequency

1 Partially behind the cecum

2 To the medial side of the cecum in the direction toward the spleen, but not reaching the brim of the pelvis In some cases it hangs over the brim of the pelvis

3 Retrocolic and totally retrocecal

4 Pre-ileal

5 Post-ileal

Congenital absence of the appendix vermiformis is an exceptionally rare occurrence In a most excellent article published in 1925, Dorland collected thirty-eight cases (including his own) in which he covered the subject to that date Spivack, in 1932, added an additional nine cases (including two of his own) Green in 1934, reported another case, thus making

a total of forty-eight cases up to date. This number represents a group of cases in which the appendix was not found on the operating-table, and another group in which it was not found on the dissecting-table. Whereas the second group is more or less reliable, the first group leaves some doubt, and, therefore, we may consider that the actual number of cases of absence

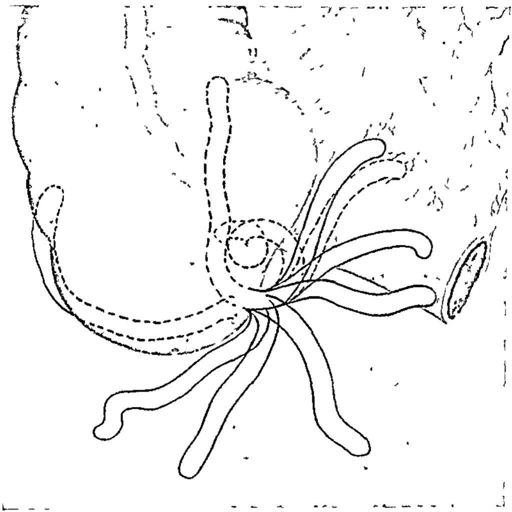


FIG. 128. Different positions of the appendix (after Kelly).

of the appendix is smaller than has been reported. But even if we accept this number as correct, we must admit that congenital absence of the appendix is a very rare occurrence, and one should not be satisfied, in case the appendix is not found, in believing that it is a case of congenital absence. In some cases the appendix is plastered to the posterior cecal wall behind the visceral peritoneum and it is difficult to find it not only on the operating, but even on the dissecting table, and lead to an erroneous conclusion of a congenital absence of the appendix.

The blood-supply of the appendix is derived chiefly from the appendicular artery This artery is very often seen as a branch of the ileo colic artery In other instances, it springs from the superior mesenteric artery below the origin of the ileo colic artery, and then it is just one of the five terminal branches of this artery It runs in the meso appendix from its root to its tip giving off on its way several small branches This artery has very poor anastomotic connections with the cecal branches of the ileo-cecal artery, and, therefore, it has many characteristics of a terminal artery Thus, when the artery is plugged, gangrene of the appendix ensues easily

The appendicular artery passes on its way to the appendix behind the terminal portion of the ileum before it enters the meso appendix There fore in case the terminal portion of the ileum is filled with fecal material, it may compress the appendicular artery and predispose the appendix to vascular disturbances

Occasionally, the appendix receives some blood supply from the cecal branches They pass over the base of the appendix in the direction toward its tip, but usually they do not reach the tip It is very important to keep in mind this occasional distribution of the blood-vessels in connection with some methods of treating the stump

METHODS OF LOCATING THE APPENDIX

In many instances there is no difficulty in locating the appendix However, in some cases this is a very difficult procedure, and it requires an exact knowledge of the anatomy to find it Occasionally, it is not easy even to find the cecum, especially when the "gridiron" incision is employed Under such circumstances it is well to use Monks method to locate the cecum This is as follows

Monks' Rule

The index finger of the right hand is introduced into the abdomen and placed on the brim of the pelvis This finger is moved over the brim of the pelvis until the pulsation of the external iliac artery is felt The finger then follows the pulsation of this artery upward to the upper edge of the brim and continues beyond upward and laterally until it reaches the blind end of a pouch This pouch actually is the lower end of the root of the mesentery In front of the index finger will lie the terminal part of the ileum (Fig 76) With the right thumb and the index finger this part of the ileum is caught and delivered outside the abdominal cavity A few inches away from this point the cecum will be located

Monks' method of locating the terminal portion of the ileum is excellent, providing that the lowermost portion of the root of the mesentery reaches the right sacro iliac joint, which is normal However, in some cases the root of the mesentery takes an entirely different direction, as was

shown by Stopnitzki and others (Fig. 74). Under such circumstances, Monks' rule will not be applicable.

As soon as the cecum is located it is turned upward, so that the posterior surface becomes anterior. About three-fourths of an inch below the ileo-cecal junction (and in the reversed position of the cecum, this is above and not below the junction) will be seen the point of convergence of the three tænia coli, where the appendix takes its origin.

In some cases the appendix lies entirely retrocecal or retrocolic and it may be difficult to find it, unless the cecum or colon is mobilized and the posterior surface turned anteriorly. However, the surgeon hesitates to mobilize the cecum or colon (which means opening the retroperitoneal space) until he is reasonably sure that the appendix is actually located there. In order to ascertain this, Spivack, in 1931, described a very simple method as follows:

Spivack's Rule (Figs. 129 and 130).

If the terminal part of the ileum is attached to the brim of the pelvis, then, in ninety per cent of all cases, the appendix is retrocecal or retrocolic. In order to expose it, the cecum has to be mobilized (if it was immobile) and its posterior wall turned anteriorly, where the appendix will be seen clearly (Fig. 130). **The reverse also holds true, namely: If there is a retrocecal appendix, in ninety per cent of such cases the terminal portion of the ileum will be attached to the brim of the pelvis.**

The surgical significance of this fact is as follows: In removal of a retrocolic or retrocecal appendix in the acute stage of inflammation, nothing else should be done. But if a retrocolic or retrocecal appendix is removed in the quiescent stage, then the operation should be supplemented by mobilization of the terminal ileum, and bringing it to its normal anatomical position, since this kink (known as Lane's kink) predisposes to intestinal obstruction.

However, occasionally in the case of a retrocecal or retrocolic appendix, the organ cannot be seen even after the cecum and colon are mobilized and the posterior wall turned anteriorly, since it may be covered with the visceral peritoneum of the cecum or colon to such an extent that it will not be exposed until the serosa is incised. In several of our cases, the appendix was found after the wall of the cecum was carefully palpated and its serosa incised.

Another important point to bear in mind is that occasionally a portion of the appendix is embedded in the wall of the cecum, with the rest of the viscus projecting from the wall of the cecum in the usual manner. In such a case, the uninitiated may remove only this projecting part of the appendix, so that he actually performs an amputation of the appendix instead of an appendectomy, and the patient may have subsequent attacks of appendicitis after an "appendectomy" has been performed. In these cases,

the appendix should be dissected from the wall of the cecum by incising the serosa of the cecum on each side of it after which the appendix is removed in the usual manner as described below When the base of the appendix (in the reversed position of the cecum) lies above the ileocecal junction it is a sign that the entire appendix is isolated

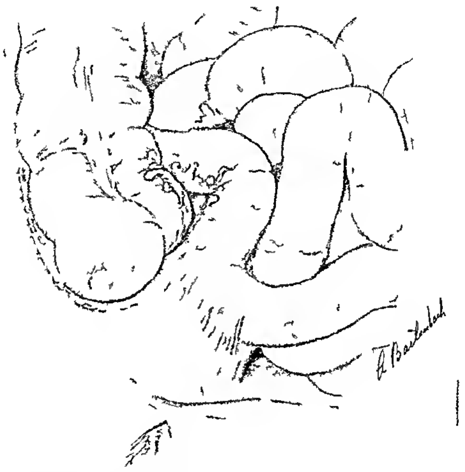


FIG 129 The Spivack rule The terminal portion of the ileum is attached to the brim of the pelvis No appendix is seen The dotted line shows where the cecum should be mobilized in order to find the retrocecal appendix

In exceptional cases the appendix may be found in the left side of the abdomen This may be due either to the fact that a complete situs inversus is present so that the location of the appendix on the left side is only a part of a general picture or that some pathological condition such as a tumor or an abscess has displaced the cecum and the appendix to the left Complete situs inversus is a rare occurrence It is met with approximately

once in four thousand autopsies, and then as a rule the appendix is on the left side. The presence of the appendix on the left side with a normal position of the other abdominal and thoracic structures, is probably never noted unless it is pathologically displaced.

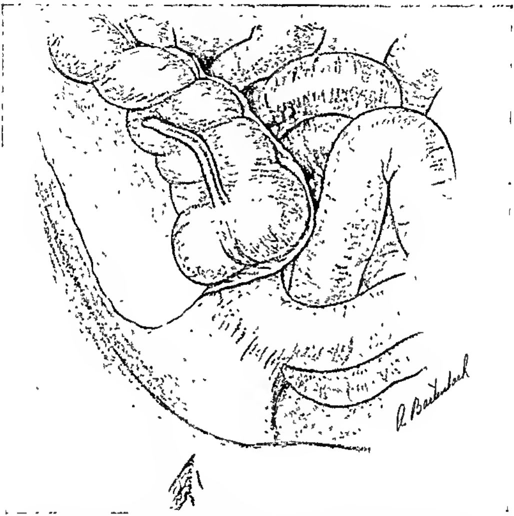


FIG 130. The Spivack rule. The terminal portion of the ileum is attached to the brim of the pelvis; the posterior surface of the cecum is turned anteriorly; the appendix lies on the posterior wall of the cecum.

When to Operate.

Operation should be performed before the formation of a mass has taken place, that is within 36 to 60 hours after the onset. If a mass is already present or there are symptoms of peritonitis at the first examination, operation should be postponed and conservative therapy instituted. The patient should he given 3,000 to 5,000 ccm. of normal saline solution

with or without glucose preferably by venoclysis, small doses of morphine sulphate, an ice-pack should be applied over a thin pad placed to the right lower quadrant of the abdomen, and neither food nor drink must be allowed for 48 to 72 hours and then only when there is evidence of improvement It is our practice to operate within 60 hours after the initial attack, provided there is no evidence of a mass

Operative Technic

Various incisions are used for appendectomy They belong to all types of abdominal incision, namely, longitudinal, transverse or oblique For their description, see Chapter II Personally, we prefer to employ the "gridiron" incision in acute cases and the transverse incision for the "interval" type

Step 1 The abdomen is opened

Step 2 The cecum is located If this is difficult to find, then the terminal portion of the ileum is located by Monks' method (Fig 76), after which it becomes a simple procedure to find the cecum The latter is brought outside the abdominal wound and the appendix is located as described above

Step 3 The part of the meso appendix which lies close to the distal end of the appendix is caught by an artery-forceps [**The appendix itself should never be grasped by an artery-forceps or by any other instrument**] (Fig 131, insert) The appendix and exposed part of the cecum are surrounded by moist laparotomy sponges

Step 4 **Ligation of the Appendicular Artery** There are several ways of doing this

The meso appendix is pierced by a curved arterial forceps very close to the base of the appendix (Fig 131, insert) The jaws of the clamp are opened and grasp one end of a thread, which is drawn through the opening, the other end passing around the meso-appendix, after which both ends are tied (Fig 131, main picture) The thread should not be tied very close to the body of the appendix In case it is difficult to do this, it can be facilitated by lifting the body of the appendix by an Allis forceps (which should not grasp the wall of the appendix itself, but the meso appendix), the blades embracing the body of the appendix with their concave surfaces The mesentery is then divided between the ligature and the body of the appendix The ends of the ligature are cut short

[An alternate method of tying the appendicular artery is as follows A clamp is placed on the meso-appendix, which is divided between the clamp and the body of the appendix If the entire meso-appendix is not caught by the first clamp, another is used to clamp the rest of the meso-appendix, which again is divided between the second clamp and the body of the appendix The meso-appendicular stump is then ligated]

Step 5. The appendix is put on the stretch by the artery-forceps which was applied to the tip of the meso-appendix, and is crushed at its base (Fig. 132). [The utmost care should be taken to see that the appendix is crushed at its base, since occasionally, as already mentioned, a portion of

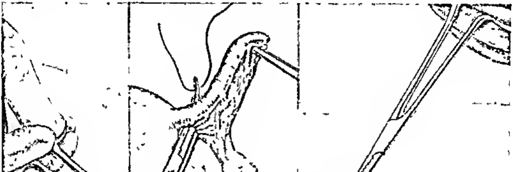


Fig. 131. Appendectomy *Insert*—An artery forceps penetrates the meso-appendix and grasps the ligature. *Main picture*—The meso-appendix is tied, the base of the appendix is clamped

the appendix is embedded in the wall of the cecum for a distance of from one-fourth to one-half inch. It is then necessary to separate this embedded portion from the wall of the cecum before the crushing-clamp is applied.] The crushing-clamp is now removed and re-applied just a little distally to the crushed base of the appendix. The appendix is then tied in the groove formed by this clamp (Fig. 132), and the ends of the ligature are cut short.

Step 6. A purse-string is placed around the appendix at a distance of one-third of an inch from its base Each seromuscular bite of this purse-string is made at a distance of one third of an inch from each other The first bite is taken at the mesenteric border by piercing the two leaflets of the meso appendix The purse-string suture is continued until half of the

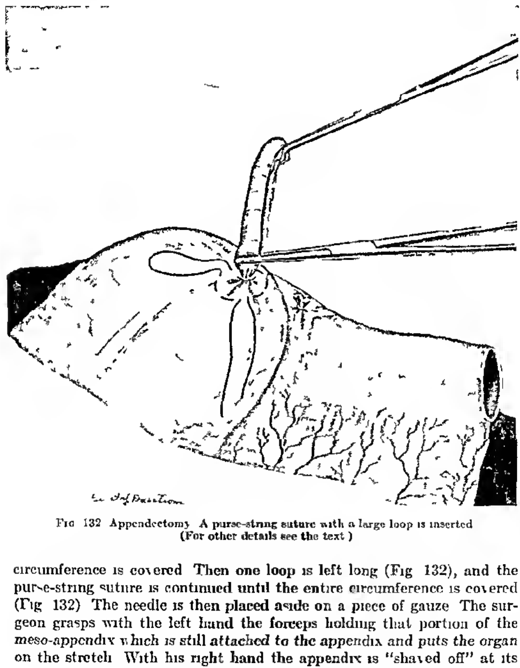


Fig 132 Appendectomy A purse-string suture with a large loop is inserted (For other details see the text)

circumference is covered Then one loop is left long (Fig 132), and the purse-string suture is continued until the entire circumference is covered (Fig 132) The needle is then placed aside on a piece of gauze The surgeon grasps with the left hand the forceps holding that portion of the *meso-appendix which is still attached to the appendix and puts the organ* on the stretch With his right hand the appendix is "shaved off" at its

base by cutting it just below the clamp between this and the tied knot. [The knife is soaked in phenol. The stump is well cleansed with the side of the knife, while the appendix is partially connected with the cecum. After the appendix is cut off entirely, the stump is cleansed with alcohol. The removed appendix with the two attached forceps and also the knife

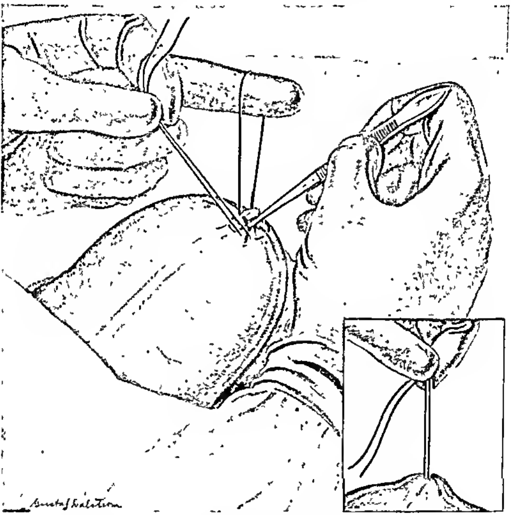


Fig. 133. Appendectomy. Invagination of the appendicular stump without the aid of the assistant.

are put aside in a special basin.] The surgeon then grasps the purse-string in the following way: The two ends of the purse-string are caught between the thumb and index-finger of his left hand, and the long loop of the purse-string by the middle finger of the same hand (Fig. 133). With the right hand, armed with anatomical tissue-forceps, the surgeon grasps the appendicular stump and presses it downward into the wall of the cecum, pulling

in the meantime with the left hand the purse string suture away from the wall of the cecum and releasing first the loop which rested on the middle finger, while the assistant supports the cecum with his right hand [The bowel should always be grasped with a pledget of moist gauze and not by the gloved fingers In this way, the stump will be buried and the ends of the purse string suture tied and cut short This suture is reinforced by several interrupted seromuscular sutures

By employing this particular maneuvre, the surgeon does not depend on his assistant either for tying the purse string or for invagination of the stump The fear of closing the ileo-cecal opening by a careless invagination of the stump seems to us to be unfounded N B Instead of cutting the appendix by a knife, the cautery may be used]

Step 7 The abdomen is closed

With reference to the management of the stump, we wish to state that the burying of the stump in the wall of the cecum is the method most commonly used by the majority of surgeons However, there are some surgeons who do not bury the stump They consider, and quite justly, that it is not a scientific procedure to bury diseased tissue in the wall of another viscus For this reason, other procedures have been suggested as follows

1 Ligation and cauterization of the stump which is allowed to drop free into the peritoneal cavity;

2 Inversion of the stump into the lumen of the cecum (Dawbarn method)

This method was suggested by Robert H M Dawbarn, in 1891 Edebohls, in 1894, suggested the same inversion method, and not knowing of the work of Dawbarn thought that it was original with him Many surgeons erroneously call this the "Edebohls method", however, the latter himself recognized the priority of Dawbarn

In this method the stump is not ligated A purse-string is made as previously described A crushing clamp is applied to the base of the appendix, and another clamp is placed just distally to the first The appendix is cut between the two clamps The purse-string is caught in the manner described above The forceps occluding the base of the appendix is removed, and an anatomical tissue forceps grasps the agglutinated end of the stump and pushes it into the lumen of the cecum The ends of the purse string are then tied to each other The rest of the operation is as already described

Some find as an objection to this method that bleeding may occur, particularly in those cases in which some of the branches of the ileo cecal artery pass from the cecal wall to the appendicular wall However, we think that this objection is not valid, since at the time that the crushing-forceps was applied to the base of the appendix it also crushed the blood-

vessels which are therein contained. We believe this method to be a very good one and without any serious objections.

3. Deaver Method (cutting the appendix flush with the cecum).

In this method the entire appendix is removed without leaving a stump. The edges of the opened cecum are closed in two layers; the first

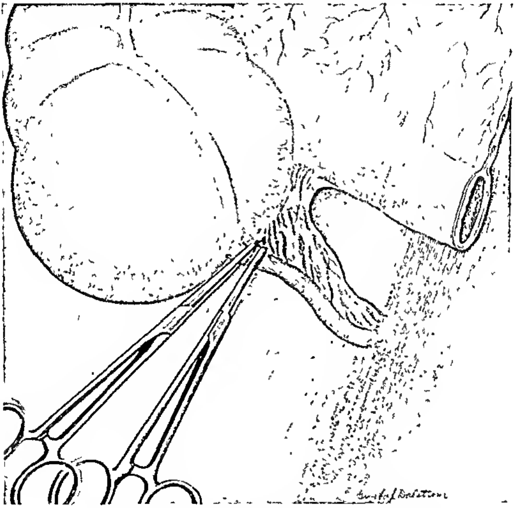


Fig 134 Retrograde appendectomy. The base of the appendix is clamped by two artery-forceps.

by an over-and-over suture and the second by a seromuscular suture. Deaver recommended this method, but advised limiting its use to the experienced surgeon.

Instead of closing the cecum by an open method, A. Monges Lopez removes the appendix flush with the cecum over an arterial clamp and closes the cecum over the clamp by a continuous seromuscular suture. This

suture line is reinforced by another layer of continuous seromuscular suture

In some cases it is more convenient to remove the appendix starting at its base This is known as the **retrograde appendectomy** It is particularly applicable when there is a long appendix which is bound down so that its tip cannot be seen or cannot be easily delivered through the wound, or in the case of an acute gangrenous appendicitis, in which the tip is gangrenous and the surgeon would prefer to deal with the gangrenous part as the last step of the operation

Technic of Retrograde Appendectomy (Figs 134, 135)

Step 1 The same as Step 1 in the previous operation

Step 2 The same as Step 2 in the previous operation

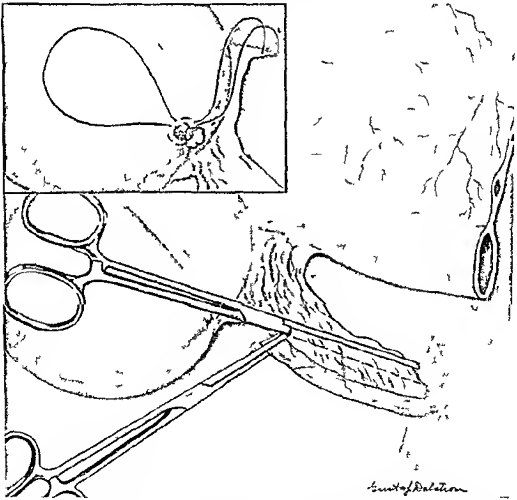


FIG 135 Retrograde appendectomy *Insert*—A purse string suture is inserted for invagination of the stump *Main picture*—The meso-appendix is clamped and ready to be incised

Step 3. Two crushing-forceps are placed at the base of the appendix perpendicularly to its long axis (Fig. 134); the forceps proximal to the cecum is then removed and the crushed base of the appendix is tied. The appendix is cut between the thread and the crushing-forceps. The stump

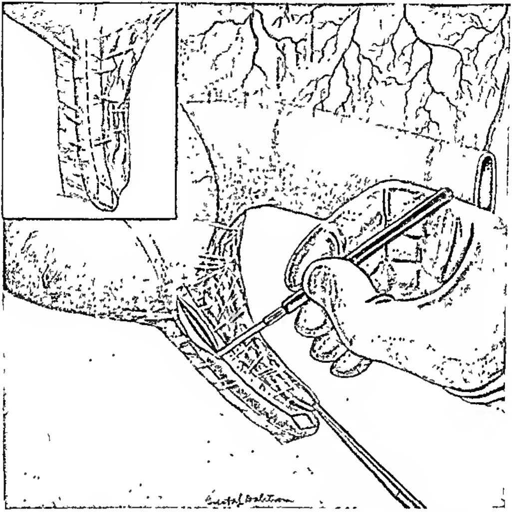


Fig. 136. Subserous appendectomy. Incision of the serosa and shelling out the mucous tube of the appendix.

is cleansed with phenol and alcohol. A purse-string suture is made, and the stump is buried as previously described (Fig. 135, insert).

Step 4. The appendix is put on the stretch by the artery-forceps which holds its severed end. A straight arterial clamp is applied to its mesentery. If the latter is too long, or if the entire appendix cannot be delivered at once, another artery-forceps is applied to the remainder of the meso-appendix, which is then cut between the arterial clamp and the body of

the appendix (Fig 135) The clamped mesenteric stump should be ligated

Step 5 The abdomen is closed in the usual way

SUBSEROUS APPENDECTOMY

This operation was first performed by Poncet, in 1899, and reported

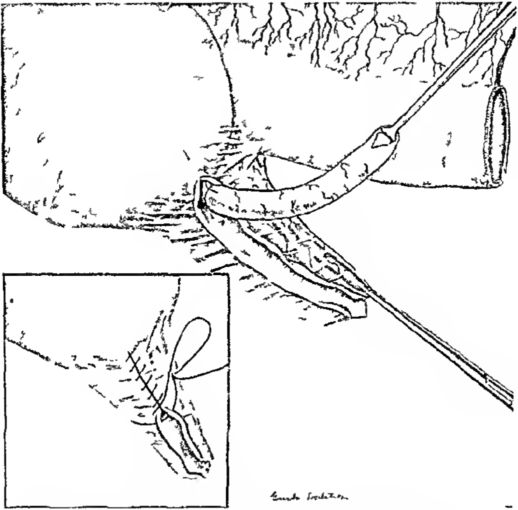


FIG 137 Subserous appendectomy *Main picture*—The mucous tube is shelled out and ligated at its base *Insert*—The tube is removed suturing of the serous layer of the appendix

in the same year by Vignard Poncet coined the expression 'subserous appendectomy' Poncin, in 1901, and Delore, in 1902, reported several cases of subserous appendectomy performed in different French clinics In 1905, Isaacs, of New York, reported several cases of subserous appendectomy, which he called "decapsulation of the appendix" He, evidently, was

not aware of the fact that this technic had been already described, and thought the procedure to be a new method of appendectomy.

This method was originally employed only for those cases in which so many adhesions were present between the appendix and the surrounding structures that it was deemed inadvisable or even dangerous to separate them. Recently some surgeons are employing it as a routine procedure for all appendices whether they be adherent or free. However, we believe that this method should be employed only in those cases in which dense adhesions are present and not in cases in which the appendix can be readily separated from the surrounding structures.

Technic.

Step 1. The abdomen is opened, the cecum and appendix located, and the latter walled off from the rest of the peritoneal cavity.

Step 2. The meso-appendix at the tip of the organ is grasped by an artery-forceps and the appendix is put on the stretch. A seromuscular incision is made beginning at the tip of the appendix in the form of a racquet, and this is continued as a linear incision along the entire length of the antimesenteric border until its base (*i.e.* its junction with the cecum) is reached (Fig. 136). Both seromuscular lips are reflected so as to isolate the mucous tube in its entire circumference at least in one place (close to the tip, since this is the safest point in case the mucosa is accidentally torn). A hook is placed around this completely isolated mucous tube, and the isolation is continued until the base of the appendix is reached (Fig. 137), which is then crushed and cut between two clamps. The proximal crushed end is tied and the stump sterilized, after which it is buried by a purse-string suture. The seromuscular lips are then sutured to each other (Fig. 137, insert).

THE TREATMENT OF AN APPENDICULAR ABSCESS

The position of an appendicular abscess is just as variable as the position of the appendix. Thus, it may be situated in the iliac, lumbar, subhepatic, subphrenic regions or in the pelvic cavity. In treating such abscesses, the same rules should be applied as in the treatment of abscesses in any other region, namely:

1. To make the opening at the most prominent point of the abscess.
2. To make it at the lowest point in order to facilitate drainage.

When the abscess is exposed and it is ascertained that its periphery is adherent to the anterior abdominal wall, the latter should then be well protected by laparotomy sponges in order to prevent its infection by the contents of the abscess. If the abscess is not adherent to the wall (and, therefore, the general peritoneal cavity is opened) then it (*i.e.* the peritoneal cavity) should be walled off from the abscess by many laparotomy sponges, and then only the abscess should be opened, its contents evacu-

ated, and the cavity carefully examined. No rough handling is permissible, since the examining finger may break through the wall of the abscess-cavity and start a general peritonitis (Fig. 139). The reason for examining the cavity (Fig. 138) is chiefly to ascertain its extent in order to know, whether the abdominal incision is sufficient for draining purposes, or

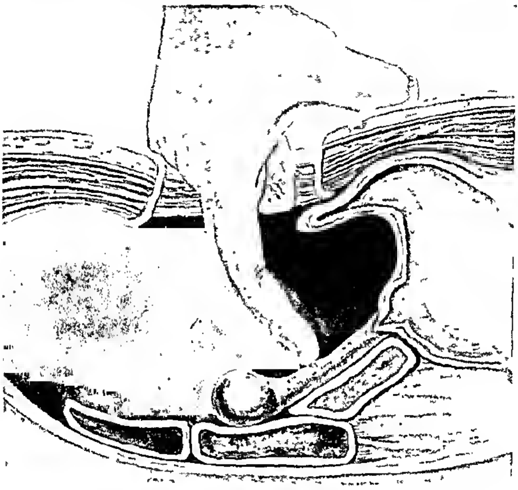


Fig 138 Correct method of exploration of an appendicular abscess (after Bosch-Arana)

whether an additional incision will be required. For drainage, a split rubber tube is very good. It is introduced in several places to afford the best drainage (Fig. 140). The drain should never be removed too soon, since this may lead to early closure of the skin-wound before the deeper structures have had time to granulate and to become obliterated Before inserting the drain, the cavity should be dusted with 5 gms. of sulfanilamide powder.

It has been a debatable question, whether the appendix should be searched for and removed while opening the abscess. It is now generally accepted that if the appendix lies free and presents itself in the cavity it should be removed. Otherwise, no search for it should be made, and it should be removed a few months later as a type of "interval" appendix.

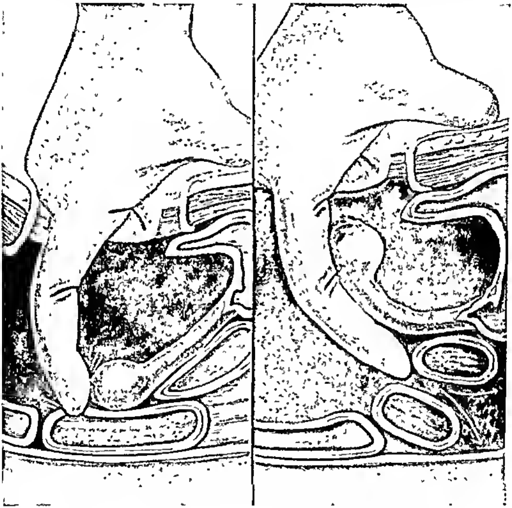


Fig. 139 Incorrect method of exploration of an appendicular abscess.

CLOSURE OF THE APPENDECTOMY INCISION

In the case of appendectomy performed for catarrhal appendicitis the abdomen is closed without drainage.

In the case of gangrenous appendicitis, or if free pus or fluid has been found in the abdominal cavity, opinions differ: The majority of surgeons drain the abdomen; however, some close the peritoneal cavity entirely by suturing the peritoneum only, and then either drain the rest of the anterior

abdominal wall, or close it completely, depending on the gravity of the infection. In the case of extremely grave infection they suture the peritoneum only, and pack the more superficial structures of the wound with hot moist gauze, not suturing them at all. We are indebted to John L. Yates of Milwaukee, who in 1905 showed the impossibility of satisfactorily drain-

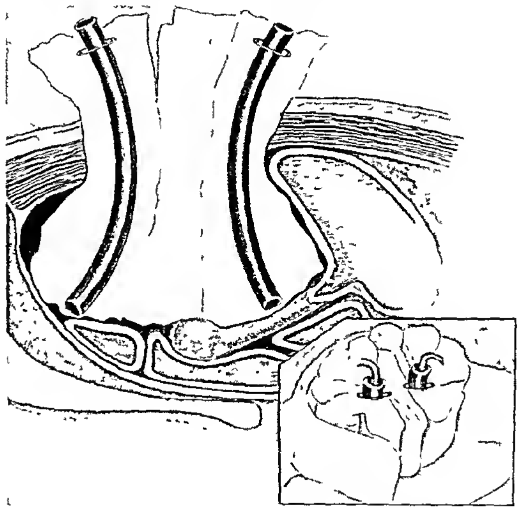


FIG 140 Drainage of an appendicular abscess (after Bosch-Arana)

ing the abdominal cavity. We do not drain, irrespective of the type of appendicitis, except, when after opening the abdomen, we consider it inadvisable to remove the appendix and, therefore, are not sure about the possible escape of intestinal contents. In clean cases we close the peritoneal cavity without dusting it with sulfathiazole; in case of gangrenous appendix we dust the cavity with 5 gms. of sulfathiazole or sulfanilamide.

So far as the abdominal wall itself is concerned we close it; if the wall is contaminated we dust it with sulfathiazole and then close it.

II. RESECTION OF THE LARGE BOWEL

The amount of bowel resected depends on several factors:

1. The character of the pathology present in the wall of the bowel.

If it is a case of tuberculosis, the amount of bowel to be removed will be slightly larger than the size of the affected area. If it is a case of carcinoma of the bowel, the amount to be removed is much larger than the actual size of the pathology present in the wall, since other considerations, such as the invasion of lymphatic glands and the vascular distribution in the bowel, necessitate far more extensive resection.

2. The manner of the distribution of the blood-vessels in the bowel.

This is actually the main factor which requires vast resection of the bowel in case of carcinoma with lymphatic involvement. Removal of the lymphatic vessels and primary glands makes imperative the ligation of the accompanying blood-vessels, and this certainly requires the resection of a large amount of bowel.

3. The lymphatic drainage of the wall of the bowel.

In the case of carcinoma of the bowel the disease is disseminated by the lymphatic vessels. The primary seat of the disease may be small, but the lymphatic vessels running from this small area may reach lymphatic glands which are situated far remote from this primary seat, and this will necessitate the removal of all this lymphatic area. The removal of such a vast area of lymphatic vessels and glands will require the ligation of a large number of blood-vessels and this means the removal of a large portion of bowel. The importance of an exact knowledge of the lymphatic drainage for intelligent surgical treatment of carcinoma of the bowel becomes paramount.

4. Mechanical considerations in restoring the continuity of the intestinal tract.

In some cases, mechanical considerations will warrant the removal of more bowel than the pathology would indicate, since otherwise anastomosis of the remaining parts may become impossible. Thus, in the case of a benign tumor of the ascending colon it may become impossible to bring the cecum to the hepatic flexure, and in such a case it may become imperative to remove the entire cecum and to bring the ileum to the hepatic flexure, which is not a difficult procedure.

In the case of resection of the bowel for any cause except malignancy, the technic is exactly the same as outlined in Chapter V. The continuity

of the tract may be restored either by an end-to end, an end to side or a side-to side anastomosis This can be done either by open methods or by the "closed aseptic methods" It is well to emphasize again that in surgery of the large bowel the "closed aseptic methods" offer the greatest advantage, greatly reducing the mortality

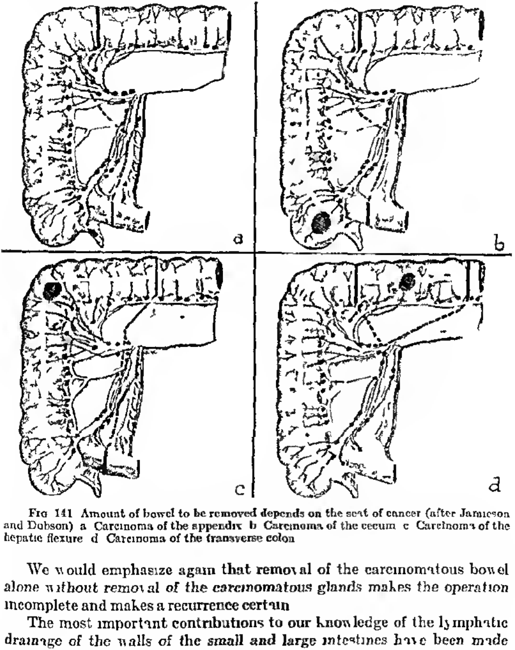


FIG 141 Amount of bowel to be removed depends on the seat of cancer (after Jamieson and Dobson) a Carcinoma of the appendix b Carcinoma of the cecum c Carcinoma of the hepatic flexure d Carcinoma of the transverse colon

We would emphasize again that removal of the carcinomatous bowel alone without removal of the carcinomatous glands makes the operation incomplete and makes a recurrence certain

The most important contributions to our knowledge of the lymphatic drainage of the walls of the small and large intestines have been made by Clado, Cunéo, Polya and von Navratil, and Jamieson and Dobson

These investigators used in their work the method of Gerota of injecting the lymphatic vessels. The outline, given below, is taken from Jamieson and Dobson. It is, however, in accordance with the results obtained by the other above mentioned investigators.

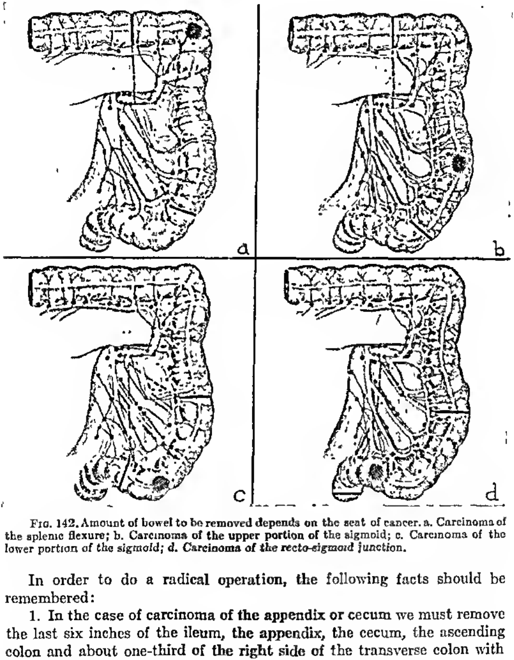


FIG. 142. Amount of bowel to be removed depends on the seat of cancer. a. Carcinoma of the splenic flexure; b. Carcinoma of the upper portion of the sigmoid; c. Carcinoma of the lower portion of the sigmoid; d. Carcinoma of the recto-sigmoid junction.

In order to do a radical operation, the following facts should be remembered:

1. In the case of carcinoma of the appendix or cecum we must remove the last six inches of the ileum, the appendix, the cecum, the ascending colon and about one-third of the right side of the transverse colon with their lymphatic areas (Fig. 141, a, b).

2. In the case of carcinoma of the hepatic flexure we must remove the

terminal six inches of the ileum, the appendix the cecum, the ascending colon, the hepatic flexure and about half of the transverse colon with their lymphatic areas (Fig 141, c)

3 In the case of carcinoma of the middle portion of the transverse colon we must remove that part of the transverse colon which includes the diseased portion of the gut and three inches of healthy gut on each side of it with the corresponding portion of the transverse mesocolon (Fig 141, d)

4 In the case of carcinoma of the splenic flexure we must remove the left third of the transverse colon, the splenic flexure and the descending colon down to the sigmoid flexure with their lymphatic areas (Fig 142, a)

5 In the case of carcinoma of the descending colon we must remove the left third of the transverse colon, the splenic flexure, the entire descending colon and the upper part of the sigmoid flexure with their lymphatic areas (Fig 142, b)

6 In the case of carcinoma of the lower portion of the sigmoid flexure and the upper portion of the rectum we must remove the entire sigmoid flexure and the upper half of the rectum with their lymphatic areas (Fig 142, c, d)

A RESECTION OF THE CECUM (CECECTOMY)

This operation is done usually in combination with the removal of the terminal portion (six to eight inches) of the ileum and a part of the ascending colon

Indications

It is done for extensive tuberculosis of the cecum

Technic

Step 1 The abdomen is opened by one or other of the usual incisions
a Transverse incision,
b Incision through the right semilunar line

In the case of a longitudinal incision through the right semilunar line Step 2 will be as follows

Step 2 Two large retractors reflect the lateral lip of the wound The cecum and ascending colon are mobilized by incising the parietal peritoneum covering the posterior abdominal wall just lateral to them (Fig 129) The inner lip of peritoneum thus produced is grasped by an artery-forceps and separated from the posterior wall of the abdomen by the index finger of the left hand placed behind it This separation is continued by moving the finger progressively closer to the median line Thus, the cecum and ascending colon will be lifted and will hang as on a mesentery, becoming as movable as the loops of the small bowel, so that finally it will be possible to deliver them outside the abdominal cavity [In mobilizing the cecum and colon care must be taken not to injure the right ureter and

the right internal spermatic or ovarian artery.] *After the mobilization of* the cecum and colon is accomplished the forceps holding the inner lip of the parietal peritoneum of the posterior abdominal wall and the retractors should be removed.

Step 3. At a point of the ileum about six inches away from the ileocecal junction the arcuate vessels are ligated exactly as is shown in Chapter V "Resection of the Small Bowel." In the same manner the arcuate vessels of the ascending colon are ligated just above the place where the colon should be divided.

Step 4. The mesentery on which hangs the terminal part of the ileum, the cecum and the ascending colon is put on the stretch and the ileo-colic *artery and as many branches of the right colic artery* which give blood supply to that part of the ascending colon which must be removed are tied. The ligation of the vessels can be done either by clamping the mesentery with artery-forceps and cutting it between them, or by piercing the mesentery by a forceps and introducing a thread through this perforation.

Step 5. Two crushing-clamps are placed very close to each other on the terminal portion of the ileum and between the ligatures which tied the arcuate vessels in such a way that they lie perpendicular to the long axis of the ileum. An intestinal clamp, the blades of which are covered with rubber tubing, is placed across the bowel perpendicularly to its long axis and two inches proximal to the proximal clamp. The bowel is cut ("shaved off") between the two crushing-clamps *so that nothing is left* on the proximal crushing-clamp. Both stumps are sterilized over the blade with phenol and alcohol (unless the bowel was cut by the cautery). The stump of the distal part of the ileum is covered with gauze which is tied to the clamp to prevent its slipping; the end of the proximal loop of the ileum is closed by the "suture over the clamp" method. The intestinal clamp which held the ileum is now removed.

Step 6. Two crushing-clamps are placed very close to each other on the large bowel between the ligatures which tied the arcuate vessels. An intestinal clamp is placed across the bowel perpendicularly to its long axis, and *two inches distal from the distal crushing-clamp. The bowel is cut, preferably by the cautery, transversely* between the two crushing-clamps. This cut should be very close to the distal crushing-clamp so that nothing is left on the clamp [if it is cut by a knife, the cut end of the bowel should be sterilized by phenol, followed by alcohol]. As soon as the large bowel is cut, the diseased portion loses its entire attachment to the body and is removed. The open end of the large bowel is then closed by the "suture over the clamp" method.

Step 7. A **lateral intestinal anastomosis** is now made between the terminal portion of the ileum and the ascending colon, the transverse *colon, or the sigmoid flexure.* [If this *anastomosis* is made between the

ileum and the ascending colon care should be taken to see that no large blind pouch is left either on the ileum or on the colon]

Step 8 By stitching the lateral lip of the parietal peritoneum to the remnant of the mesentery the bed of the cecum and ascending colon will be peritonized (Fig 143)

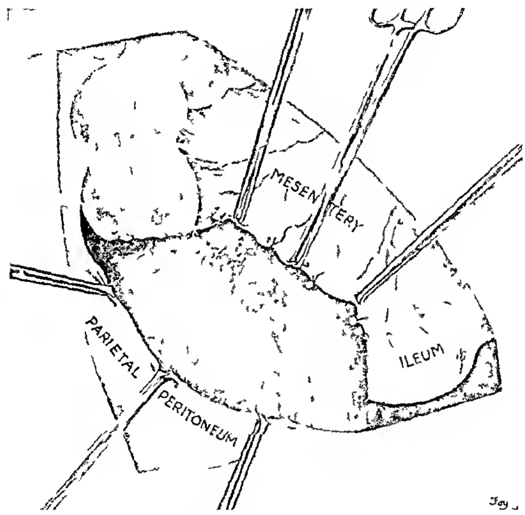


Fig 143 Peritonization of the posterior wall of the abdomen

As has already been noted, if the cecum, or even the appendix, is removed because of a malignant growth then the mere removal of the terminal six inches of ileum and of the appendix and the cecum is not sufficient In such cases it is necessary to remove the terminal six inches of the ileum, the cecum, the ascending colon and the right third of the transverse colon This is what is known as

B. THE FRIEDRICH OPERATION

This operation is performed for malignancy of the appendix alone, or of the appendix and cecum, or of the appendix, cecum and ascending colon.

Step 1. Abdominal section is made.

Step 2. The same as Step 2 of the previous operation, with the exception only that the incision of the parietal peritoneum lateral to the ascending colon should be made upward to the level of the hepatic flexure, and then when stripping the inner lip of the parietal peritoneum the finger should reach upward and medially to the second part of the duodenum as well as to that portion of the third part of the duodenum where the superior mesenteric artery crosses the bowel.

Step 3. The same as Step 3 in the previous operation.

Step 4. The same as Step 4 of the previous operation, with the understanding, of course, that not only the branches of the right colic artery, but the artery itself should be ligated very close to its origin either from the ileo-colic artery or from the superior mesenteric artery, and that the attachment of the lateral few inches of the transverse colon should be separated from the duodenum.

Step 5. The same as Step 5 in the previous operation.

Step 6. The same as Step 6 in the previous operation.

Step 7. A lateral intestinal anastomosis is made between the terminal portion of the ileum and the transverse colon or the sigmoid flexure.

Step 8. The bed of the cecum, ascending colon and of the removed portion of the transverse colon is peritonized by suturing in the manner described above.

C. RESECTION OF THE COLON FOR CARCINOMA OF THE HEPATIC FLEXURE

Due to the course of the lymphatic drainage from the hepatic flexure, it is necessary to remove the last six to eight inches of the terminal ileum, the cecum, the ascending colon, the hepatic flexure, and two to three inches of the transverse colon together with the glands into which the lymphatic vessels of these regions drain (Fig. 141, c). Since, in order to remove all the lymphatic glands from this region, it will be necessary to ligate the middle colic artery close to its origin, therefore, it will be necessary to resect about half of the transverse colon, otherwise there might result gangrene of the right half of the colon. The technic is exactly the same as in the previous operation, with the difference only that the middle colic artery and vein must be ligated.

D. RESECTION OF THE TRANSVERSE COLON

In the case of malignancy of the central portion of the transverse colon, since the lymphatics do not spread beyond the limits of the part of the bowel affected, it is sufficient in order to effect a radical cure to resect

only the affected part of the bowel with two to three inches of healthy tissue on each side of the growth (Fig. 141, d).

Technic.

Step 1. The abdomen is opened by a midline or a transverse incision.

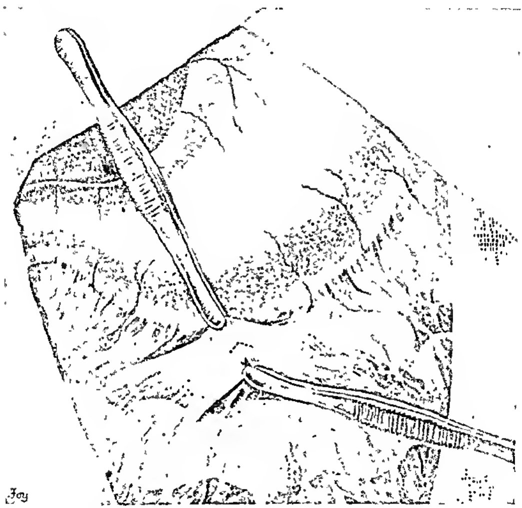


FIG. 144. Excision of the transverse colon. The gastrocolic ligament is cut between two tissue-forceps.

Step 2. Ligation is made of the gastrocolic ligament for a length corresponding to the length of the portion of the transverse colon to be removed. This is done in the following manner:

The gastrocolic ligament is grasped between two tissue-forceps between which it is cut (Fig. 144). [Care should be taken not to cut through the transverse mesocolon which lies so close to the gastrocolic ligament

that they appear as a single layer.] *A curved artery-forceps is introduced* into the opening in the gastrocolic ligament and this opening is enlarged by spreading the blades. The index-finger of the left hand is then introduced and gently separates the gastrocolic ligament, which lies in front of the finger, from the transverse mesocolon, which lies behind the finger (Fig. 231). Two artery-forceps are then placed on the gastrocolic ligament, one on each side of the intended line of incision, and the ligament is cut sectionally between the forceps. The finger acts as a protector for the transverse mesocolon (Fig. 231).

Step 3. Those branches of the middle colic artery which give the blood-supply to the portion of the bowel to be resected must be ligated and also the arcuate vessels at the ends of the section of the bowel to be removed.

Step 4. The part of the omentum attached to the resected portion of the colon is cut away from the rest of the omentum. The cutting should be done between two artery-forceps. [*Large bites of the omentum should not be taken.*]

Step 5. An artery-forceps is placed at each end of the bowel to be resected and a Partipilo clamp just lateral to each of these clamps. The bowel is cut between each artery-forceps and the Partipilo clamp by a knife, or still better by the cautery.

Step 6. The continuity of the colon is restored by making an end-to-end anastomosis as described in Chapter VII.

Step 7. The lips of the transverse mesocolon are sutured together.

Step 8. The abdomen is closed.

E. RESECTION OF THE SPLENIC FLEXURE

If it is necessary to remove the splenic flexure on account of malignancy, the radical operation then is very extensive because of the necessity *of removing the spleen, since the lymphatics of the splenic flexure drain* also into those of the spleen. However, surgeons usually confine their work to removal of the left half of the transverse colon, the splenic flexure, and the descending colon, and then restore the continuity of the intestinal tract by making an end-to-end, an end-to-side or a side-to-side anastomosis between the remaining parts of the transverse colon and the sigmoid flexure. All three procedures do not offer mechanical difficulties, since both the transverse colon and the sigmoid are movable.

Step 1. Abdominal incision is made (left semilunar or transverse).

Step 2. The descending colon is mobilized precisely in the same manner as was described in "Mobilization of the Ascending Colon."

Step 3. The costocolic ligament is divided between two clamps [this loosens the fixed portion of the splenic flexure]. The left half of the transverse colon is separated from the stomach by severing the gastrocolic ligament in the manner described in the previous operation.

Step 4 The left branch of the middle colic artery and the ascending branch of the left colic artery are ligated, and the mesentery is divided longitudinally between the artery forceps in the same way as described in the previous operation The mesocolon is divided along the line shown in Fig 142 a

Step 5 Arterial clamps and Partipilo crushing clamps are placed on the bowel precisely in the same manner as described in the previous operation and the bowel is divided between each arterial and Partipilo clamp by a knife or preferably by the cautery

Step 6 An end to end anastomosis is made between the remaining portions of the bowel

Step 7 The denuded bed of the descending colon is peritonized by suturing the lateral lip of the parietal peritoneum to the remnants of the mesocolon If it is impossible to bring these together the parietal peritoneum must be mobilized

Step 8 The abdomen is closed

If it is decided to reestablish the lumen of the intestinal tract by making a lateral intestinal anastomosis the procedure then is somewhat different thus

Steps 1 to 4 the same as in the previous operation

Step 5 Two arterial clamps are placed on each end of the bowel to be removed The bowel is resected between each pair of clamps and each end of the bowel is closed blindly

Step 6 A lateral intestinal anastomosis is made in the usual way

Step 7 The denuded bed of the descending colon is peritonized precisely in the same way as described in Step 7 of the previous operation

Step 8 The abdomen is closed

F REMOVAL OF THE DESCENDING COLON

Due to the lymphatic arrangement in the case of malignancy of the descending colon this portion of the colon should be removed together with the splenic flexure and the left half of the transverse colon The difference in the amount of bowel removed in cases of malignancy of the splenic flexure and of malignancy of the descending colon is that in the latter the lower end of the resected bowel should be at the upper part of the sigmoid flexure The technic of resection is precisely the same as described in Removal of the Splenic Flexure

G REMOVAL OF THE SIGMOID FLEXURE

In the case of malignancy of the sigmoid flexure it is necessary to remove the lower half of the descending colon and the entire sigmoid flexure down to the sigmoido rectal junction The technic is essentially the same as that in the case of resection of the splenic flexure with some additional steps which are described below

Step 1. Abdominal section is made through the left semilunar line.

Step 2. The descending colon is mobilized in its lower half precisely as described in "Mobilization of the Ascending Colon." However, if it is seen that after the resection of the lower half of the descending colon there will be difficulty in making an end-to-end anastomosis between the upper portion of the descending colon and the rectum, then it will be necessary to mobilize the entire length of the descending colon and the splenic flexure. The sigmoid portion of the bowel should be mobilized in the following way:

An incision is made in the parietal peritoneum just lateral to the sigmoid. This incision is carried downward to the brim of the pelvis, and then still further downward to the place where the peritoneum of the urinary bladder (in the male) or the uterus (in the female) is reflected onto the anterior wall of the rectum [this is usually at the level of the second or third sacral vertebra]. This part of the bowel is mobilized precisely as in mobilization of the ascending colon [while doing this care should be taken not to injure the left spermatic artery and left ureter]. The reflection of the peritoneum from the bladder (in the male) or the uterus (in the female) onto the rectum is cut across in front of the rectum. Then the parietal peritoneum is incised one inch away from the right side of the rectum and sigmoid. When the promontory is reached, if the middle sacral artery is in the way, it should be ligated and cut between two ligatures. The leaflets of the parietal peritoneum from which the descending colon and sigmoid are suspended, are treated precisely in the same manner as described for resection of any other portion of the large bowel. The rest of the operation differs, depending on whether it is desired to reëstablish the continuity of the gastro-intestinal tract or to resort to the formation of an artificial anus. In the latter case the next step will be:

Step 3. Two crushing-clamps are placed on the rectum which is cut between them. The distal end is closed blindly.

Step 4. A crushing-clamp is placed at the proximal end of the gut to be removed, and two inches proximal to it an intestinal clamp, the blades of which are covered with rubber tubing, is placed across the bowel which is cut off just proximal to the distal clamp, and the gut removed. The proximal end of the bowel is then attached to the anterior abdominal wall.

If, however, it is decided to reëstablish the continuity of the gastro-intestinal tract, then:

Step 3. A crushing-clamp is placed on the distal end of the gut to be removed, and another on the proximal end. Two inches proximal to the proximal clamp an intestinal clamp is placed across the gut, which is cut distal to the distal clamp and proximal to the proximal crushing-clamp. The continuity of the intestinal tract is then reëstablished either by a plain end-to-end anastomosis or with the aid of a rubber tube. In the latter case, this is done in the following manner:

Step 4 The assistant everts the lower segment of the rectum A rubber tube is introduced into the proximal end of the sigmoid and secured there by a chromic catgut stitch The other end of the rubber tube is inserted into the everted portion of the rectum until its end protrudes through the anus The assistant then pulls this tube downward so that a portion of the upper segment of the rectum is telescoped through the entire length of the lower segment These ends are then sutured to each other by a series of over and over interrupted sutures, after which the bowel is pulled upward so as to replace in its normal position the everted portion of the rectum and anus

Step 5 The abdomen is closed

Step 6 The coccyx is removed, thus exposing the line of anastomosis, which is reinforced by another layer of interrupted seromuscular sutures

II RESECTION OF A BOWEL IN SEVERAL STAGES

This type of operation belongs to the earliest group of operations in which, because of high mortality of the one stage operation, the surgeons preferred to perform it in several stages With the improvement in surgical technic this type is now reserved only for those cases in which intestinal obstruction is already present and the patient cannot stand more than a mere colostomy A very widely used method for this class of cases is

Mikulicz Method

This is done in four stages

Technic

First Stage

Step 1 The abdomen is opened by a left gridiron or by a left pararectus incision

Step 2 The sigmoid is located The mesentery of the sigmoid is ligated and cut in a "V" shape [It should be kept in mind that not only the blood vessels distribution but also the area of lymphatic drainage should be considered before deciding the amount of bowel to be removed]

Step 3 The portions of the bowel lying in close proximity to the portion to be removed are laid side by side A seromuscular suture connects them either on one or on both sides (Fig 145, a)

Step 4 A suture fixes each loop of the "double barrel" to the peritoneum in its vicinity

Several days (4 to 7) later the second stage is performed

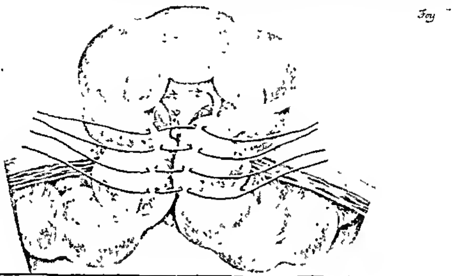
Second Stage

Step 1 The bowel lying on the skin is resected leaving only about one and one half inches of bowel above the surface of the skin

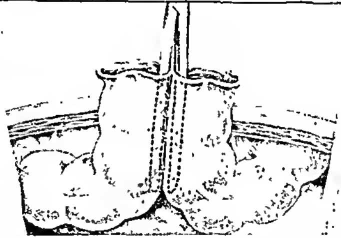
Several days later (5 to 7 after the second stage) the third stage is done

Third Stage.

Step 1. An enterotribe with blades four inches long is introduced into the lumen of each bowel-opening (Fig. 145, b); the lock is closed slightly. Each day the enterotribe is locked a little firmer than on the previous day.



a



b

Fig. 145 Resection of the large bowel by the Mikulicz method a. Suturing two loops by interrupted seromuscular sutures, b. Crushing the wall by an enterotribe.

In a few days (on the average, five to seven) the intestinal wall between the two loops is crushed, so that a spur is no longer present.

The next stage is done from a few days to two weeks later:

Fourth Stage.

Step 1. The edges of the intestinal wound are freshened and mobilized. [Care should be taken not to mobilize the loops behind the peri-

toneum] The intestinal lips are sutured to each other by an over-and-over suture and then reinforced by a sero serous suture

The skin is closed either immediately or a few days later

III COLOSTOMY

The word colostomy is composed of two Greek words κολον, colon and στομα, mouth, it is an artificial communication between the lumen of a bowel and the outside world

The site of the colostomy depends on the location of the pathology As it is done more frequently for malignancy of the rectum than for any other portion of the bowel, it is usually done in the sigmoid flexure However, the opening is infrequently made in the cecum the ascending colon, the transverse colon or in the descending colon The opening may be temporary only, and then the operation is called *'temporary colostomy,"* or it may be made as a permanent affair and then it carries the name of a "permanent colostomy"

If the communication has been established intentionally it is called an **"artificial anus,"** and if the communication came spontaneously as the result of pathological changes in the bowel-wall it is then called a **"fecal fistula"** If the opening is made in the appendix, it is called **appendicostomy,** if in the cecum, **cecostomy,** if in the sigmoid flexure, **sigmoidostomy**

The site of the abdominal incision depends on the part of the bowel to be opened Thus, in the case of cecostomy it will be in the right iliac region, in the case of making an opening in the transverse colon, it will be a longitudinal or a transverse incision in the epigastric region, and in the case of a sigmoidostomy, in the left inguinal region

Historical

An excellent article on "The Origins and Evolution of Colostomy" was written by Tilson Dinnick, of London, and published in the British Journal of Surgery, in July, 1934 We quote freely from this article for the historical review of colostomy

Accidental colostomies, due to injury of the bowel were known from remote antiquity The earliest suggestion of this occurrence is probably that which is mentioned in the Bible, in the "Book of Judges," where we read that Ehud stabbed Eglon, the King of Moab "and his dirt ran out and he died" Coelius Aurelianus states that Praxagoras (who lived four hundred years before Christ), among the different methods used to cure ileus suggested making an opening in the abdomen, incising the bowel, evacuating its contents, and then closing the bowel and the abdominal wall

However, the credit for deliberately advocating the use of colostomy to relieve obstruction is given to the French surgeon Littré, who, in 1710,

advocated this procedure in the case of an imperforate anus in an infant. The first who actually performed it, in the form of a right inguinal colostomy (cecostomy) was Pillore, a surgeon of Rouen, who did it in 1776 on a patient suffering from carcinoma of the rectum. Duret, in 1793, was the first who performed a left lumbar colostomy on an infant for imperforate anus. Thus he preceded Callisen to whom erroneously is given the credit for being the first who introduced lumbar colostomy.

The first colostomy made in the transverse colon was done by Fine, of Geneva, in 1797. It was done as an error, since he thought, at the time of operation, that he was doing an ileostomy, and only the subsequent autopsy on the patient showed that instead of the ileum the transverse colon had been opened. Callisen, of Copenhagen, published in 1800 his "Systema Chirurgiæ Hodiernæ" in which he advised performing a lumbar colostomy. Although he does not claim originality for this method, and mentions the names of several men who did it before him, nevertheless many erroneously consider him as the originator of this operation. Freer, of Birmingham, was the first to perform a colostomy in England, in 1815.

However, this operation has been used only occasionally by a few daring surgeons. Only since Amussat, of Paris, described in detail its technic, in 1839, has lumbar colostomy become the operation of choice. It held this position until Allingham, Jr. showed, in 1887, the advantage of the inguinal approach, which, together with other types of anterior abdominal approach, replaced entirely the lumbar route.

F. T. Paul, in 1890, described his glass-tube, which enabled the surgeon to open the bowel immediately, whenever it was deemed necessary. Schitzinger was the first who, in 1881, divided the exteriorized bowel completely, thus making two openings which were entirely separated from each other.

By using the "two-stage" method, in which the bowel is delivered and attached to the skin as the first stage, and opened a few days later as the second stage, this operation becomes a safe procedure. The only difficulty that confronts the surgeon now is making the opening "water-tight" and "gas-tight." Many ingenious devices have been offered to make the opening "water- and gas-tight," but the last word has not yet been said.

Indications.

1. In the case of an obstruction of the large bowel.
2. As a preliminary step to removal of the rectum.
3. As a preliminary step in surgery of the rectum, when it is not necessary to remove the latter.
4. To give rest to the bowel in certain pathological conditions, such as ulcerative colitis, etc.
5. Appendicostomy or cecostomy has been used by some surgeons as a

routine procedure in the treatment of perforation of the appendix with peritonitis

The technic of colostomy varies, depending on whether a permanent or a temporary colostomy is to be established

A PERMANENT COLOSTOMY OR ARTIFICIAL ANUS

In making a permanent colostomy several factors must be taken into consideration

1 All the fecal material should escape through the colostomy opening No fecal material should pass into the distal loop This can be accomplished by making a spur between the designated proximal and distal loops, and then by making the opening in the proximal loop

2 The opening should be "watertight" This means that no fecal material should escape through the opening involuntarily Many ingenious methods have been devised to accomplish this requirement, but the great majority of them are unsatisfactory This is the reason why surgeons rely more on different mechanical appliances (such as cups), on diet or on a constipation habit of the patient, than on mechanico-physiological apparatus made of the human structures

3 No loop of small bowel should be caught between the large bowel and the abdominal wall to which it is attached in order not to produce an intestinal obstruction

4 There should be no retraction of the proximal loop into the abdominal cavity or into the abdominal wall

5 There should be no prolapse of the proximal loop

a Left Inguinal Colostomy.

First Stage.

Step 1 The abdomen is opened by a "gridiron" incision precisely as for appendectomy, with this difference only that the incision is made on the left side The length of the incision is three inches (Fig 146, a)

Step 2. The index finger of the right hand is introduced behind the lateral lip of the abdominal incision and is directed laterally until it reaches the lateral border of the abdominal cavity It then moves downward until the posterior abdominal wall is reached, and then medially until the mesosigmoid is reached Then the finger follows the mesosigmoid until the mesenteric border of the sigmoid flexure is reached, which is then grasped by the finger and brought outside the abdominal cavity

Step 3 The proximal portion of the sigmoid is drawn outside the abdominal cavity until it is placed on a moderate stretch The drawn-out portion of the bowel is placed in the form of a horse-shoe The mesenteric border of the arch thus produced at its summit should lie about one and one-half inches above the level of the skin

Step 4. With the Pagenstecher linen thread, or a silk thread, the middle of the inner lip of the abdominal wall is pierced through its entire thickness (skin, fascia, external oblique muscle, internal oblique muscle, transversus abdominis muscle, transversalis fascia and the peritoneum).

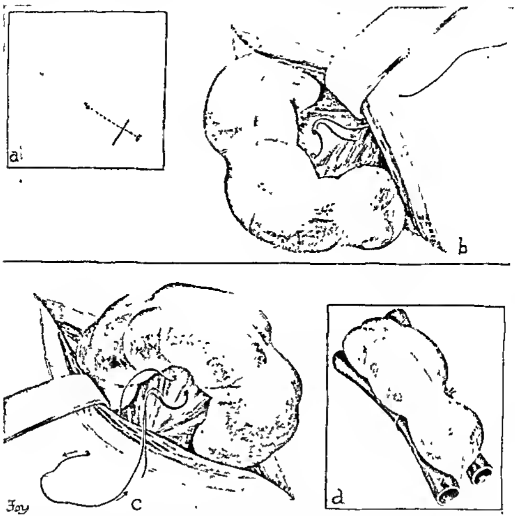


FIG 146 Left inguinal colostomy. a. Skin incision; b. Suturing the mesocolon to one of the abdominal lips; c. Suturing the mesocolon to the other abdominal lip, d Final view. (Pictures b, c and d are seen from the left side of the patient).

Then the needle passes through a bloodless spot on the mesentery about one inch away from the mesenteric border of the bowel (Fig. 146, b), then through the entire thickness of the lateral lip of the abdominal wall from within outward, then again through the mesentery very close to the point where the thread previously passed through, and the thread is brought over the inner lip. Thus, a loop of thread will lie on the skin of the outer lip with its two ends resting on the inner lip (Fig. 146, c). A rubber tube

is then placed in the loop and another between the free ends of the thread, which are tied snugly (Fig 146, d) The reason for placing the rubber tubes is to prevent the thread from cutting through the skin, while the ends are snugly tied The wound is then covered with gauze abundantly impregnated with vaseline The opening of the bowel is postponed for four or five days, after which the "second stage" is performed

Second Stage

Step 5 The proximal loop of the bowel is opened by a transverse incision the length of which is about two thirds of its circumference This incision should not lie very close to the skin, so that in case of a future retraction of the loop it will not slip behind the level of the skin [The technic, as described above is highly recommended by Moynihan for use in the permanent as well as in the temporary type of colostomy]

If, however, after completing the "First Stage" of the operation, the patient begins to complain of severe gas-pain and Step 5 cannot be postponed at least for 24 hours, or if it is an acute case of obstruction of the colon in which the opening in the bowel must be made immediately, then as there is no time for the formation of protective adhesions, it is necessary to introduce a rubber, or still better, a glass tube Then Step 5 will be as follows

Step 5. A purse-string seromuscular suture is made on the free (antimesenteric) border of the proximal limb The diameter of the circle should be about half an inch The wall of the bowel is caught inside of the purse-string by an Allis forceps and is opened by one snip of the scissors Then the Allis forceps is drawn upward, which will prevent the escape of the intestinal contents A glass tube is immediately introduced and the ends of the purse-string are tied snugly around the tube

This operation, performed as described above, is very simple, its execution requires only about ten minutes The single suture will keep the spur above the skin until adhesions are formed As can be seen, the bowel is sutured at no point to any layer of the abdominal wall

In order to give support to the protruding bowel Audry and later Mixter made a bridge consisting of the entire thickness of the anterior abdominal wall, which acted as a good support for the protruded bowel Their technic is as follows

b Audry-Mixter Method.

Step 1. A  shape incision is made through the skin, superficial and deep fascia until the anterior sheath of the left rectus muscle is reached This incision starts at the level of the umbilicus at the lateral border of the left rectus muscle, and runs first vertically downward (AB) for a length of two inches Then another limb of the incision is made (BC) perpendicular to the first one which runs medially until the midline is

reached. It is then turned downward along the median line (CD) for another two inches, and then laterally perpendicular to the linea alba until it reaches the lateral border of the left rectus muscle. The incision is then turned downward parallel to the linea alba (EF) for another two inches (Fig. 147, insert). The quadrangular flap BCDE is then reflected laterally

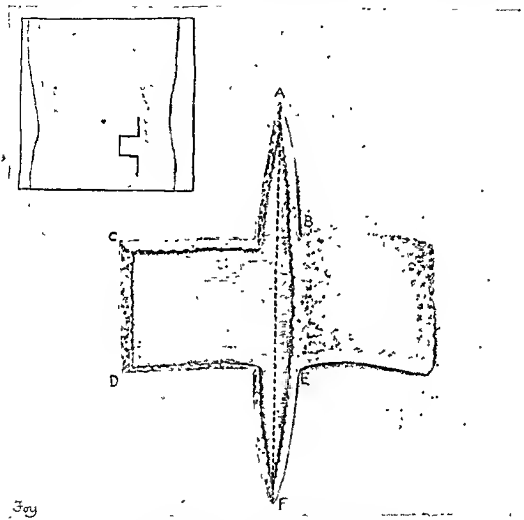


Fig. 147. Audry-Mixter method of colostomy. *Insert*—Skin incision. *Main picture*—The cutaneous flap is reflected.

(Fig. 147). The rectus muscle is then split from the point A downward to the point F (that is for the length of six inches), and the posterior sheath and the peritoneum are opened longitudinally along the same line AF.

Step 2. The sigmoid is located and brought outside. The loop for the colostomy is selected precisely in the same manner as described in the previous operation.

Step 3 A longitudinal incision two inches in length is made in the mesosigmoid perpendicular to the long axis of the bowel The middle of each lip of the split rectus muscle is sutured to the other through the rent in the mesosigmoid Then the quadrangular skin flap is carried through the rent in the mesocolon and replaced in its original position and sutured

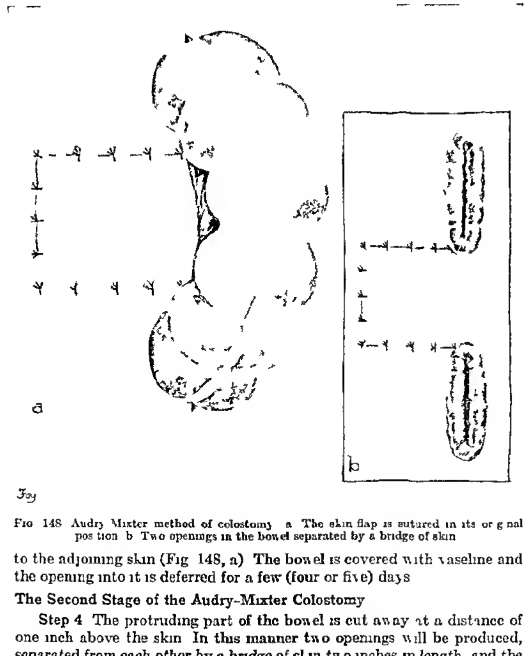


Fig 148 Audry Mixter method of colostomy a The skin flap is sutured in its original position b Two openings in the bowel separated by a bridge of skin

to the adjoining skin (Fig 148, a) The bowel is covered with vaseline and the opening into it is deferred for a few (four or five) days

The Second Stage of the Audry-Mixter Colostomy

Step 4 The protruding part of the bowel is cut away at a distance of one inch above the skin In this manner two openings will be produced, separated from each other by a bridge of skin two inches in length and the contents of the proximal loop cannot escape into the distal loop (Fig 148,

b). The opening of the distal loop may serve for the purpose of medication.

This method was first described by Audry, and Mixter described it later, being unaware of the work of the former.

Although this method prevents the escape of the contents from the proximal into the distal loop, and also the retraction of the bowel, nevertheless *it is not watertight, a most distressing condition to the patient.* The same type of flap incision "  " made only lateral from the outer border of the rectus muscle, is used by some surgeons, and is known as the Jeannel incision.

In order to make the colostomy opening watertight Kurtzahn, in 1920, suggested two methods. One consisted in making two tubes from two skin-flaps and then carrying each tube through a subcutaneous channel around the portion of the bowel on which the colostomy opening was contemplated; these two tubes met below the gut so that they encircled it in the form of a sphincter. However, in a later work in the same year he suggested another method, which is as follows: A skin-tube is made out of a skin-flap. This tube is carried through a hole in the mesosigmoid, which is brought outside the abdominal cavity, and then the tube is fastened to the other lip of the skin. Thus, the sigmoid rests on a skin-tube. A metallic rod is placed in the lumen of the tube. A pellet is placed outside on the bowel, so that the latter is compressed between these two foreign bodies. This method was further improved by R. Haecker, in 1923, and since that time has been used by many surgeons, many of whom have been well pleased with the method.

c. Kurtzahn-Haecker Method.

Step 1. A quadrangular skin-incision is made in front of the left rectus muscle at the level of the umbilicus (Fig. 149, a). The width of this incision is 6 cm. and the length about 5 cm. The base of this incision lies on the left semilunar line. This flap is reflected from the underlying tissues and transformed into a tube (Fig. 149, b).

Step 2. The abdomen is opened by a longitudinal incision running along the lateral border of the rectus muscle. The sigmoid is delivered outside. A hole is made in the mesosigmoid through which the skin-tube is carried to the inner lip of the opened abdomen. Here it is fixed at two points to the skin of the inner lip (Fig. 149, c).

Step 3. The upper lip is sutured to the lower one over the bowel, leaving a small opening in the skin in the lower angle through which the bowel is seen (Fig. 149, d).

Step 4. The bowel is opened at the lower angle, a few days after steps 1 to 3 have been performed.

A clamp with rubber tubing on its blades is applied in the following manner: One blade of the clamp passes through the cutaneous canal, lying

behind the gut. Another blade lies in on the skin front of the gut. The clamp is locked Thus, not only feces but even gas will not pass through the clamped bowel.

However, the objection to this method lies in the fact that mechanical appliances are required to make the opening watertight. In order to elimi-

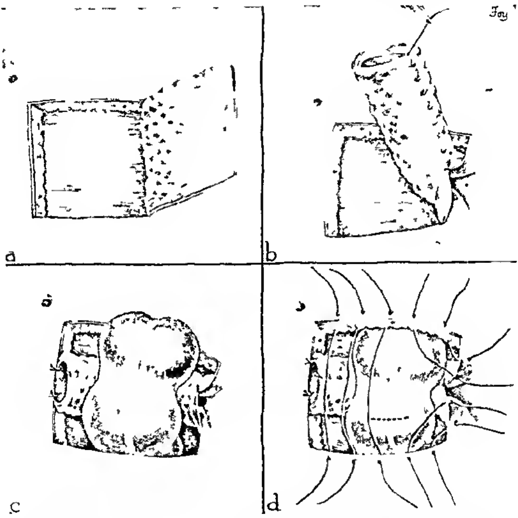


FIG 149 *Kurtzahn Haecker method of colostomy* a *The cutaneous flap is made,* b Formation of a tube from the flap, c The tube is carried through an opening in the mesosigmoid and sutured to the opposite side, d Closure of the skin over the bowel

nate any mechanical appliances, Spivack devised a method in which a tubo-valvular apparatus is made out of the bowel, which makes the opening watertight without employing any mechanical appliances.

d. Spivack Tubo-valvular Colostomy (Fig 150).

First Stage.

Step 1. The abdomen is opened by a left "gridiron" or left pararectus incision. The sigmoid is delivered outside the abdomen. A slit is made in the mesosigmoid, and the lips of the anterior abdominal wall are sutured to each other in layers. Thus the bowel rests on the bridge of the anterior abdominal wall.

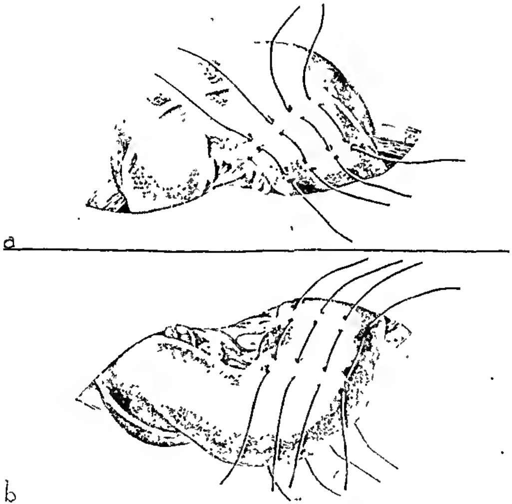


FIG. 150. Spivack tubo-valvular colostomy. a. Inserting sero-serous sutures on one side of the bowel; b. Inserting sero-serous sutures on the other side of the bowel.

Step 2. Several seromuscular-seromuscular sutures are inserted in the proximal loop of the sigmoid (Fig. 150, a, b). The distance between the insertions of each thread is about three-fourths of an inch. The distance between the successive threads is half an inch. These threads are placed so as to be inserted into the entire circumference of the bowel. The ends of each thread are tied and cut short.

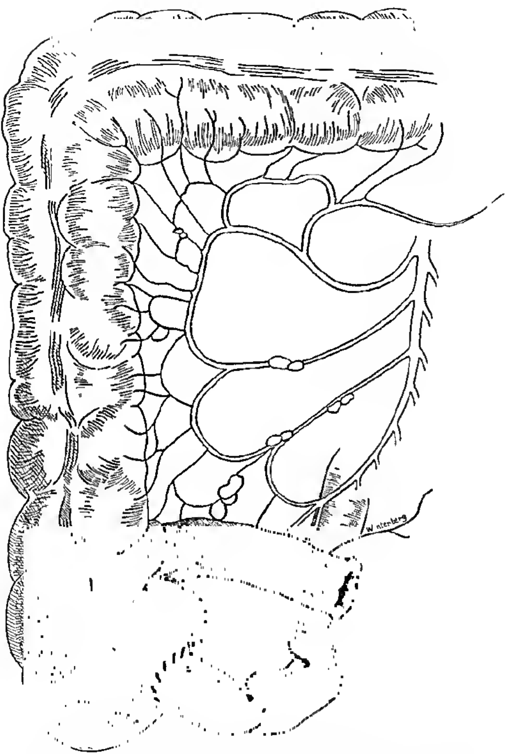


Fig 151 Spivack method of the formation of an artificial anus The terminal ileum is divided and the proximal portion implanted into the cecum

Second Stage.

The bowel is cut transversely a few days after the first stage. Thus, we have a valve at the proximal portion of the bowel not far from its mouth. This will prevent the escape of feces.

In those cases in which a permanent ileostomy is contemplated for extensive pathology of the large bowel but in which the cecum is not pathologically altered, Spivack devised the following operation:

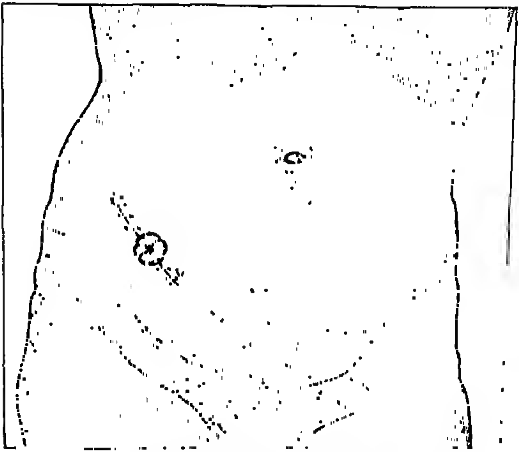


Fig. 152. Spivack method of the formation of an artificial anus. The distal end of the divided ileum serves as an abdominal anus.

e. Spivack Method of Construction of an Artificial Rectum and Anus.

This operation consists in dividing the terminal portion of the ileum, implanting the proximal end of the divided bowel into the cecum, bringing outside the abdominal cavity the distal end of the divided ileum and fastening it to the anterior abdominal wall, dividing the cecum completely from the ascending colon and closing blindly both ends of the divided bowel. Thus, a receptacle is formed (from the cecum) for the storage of

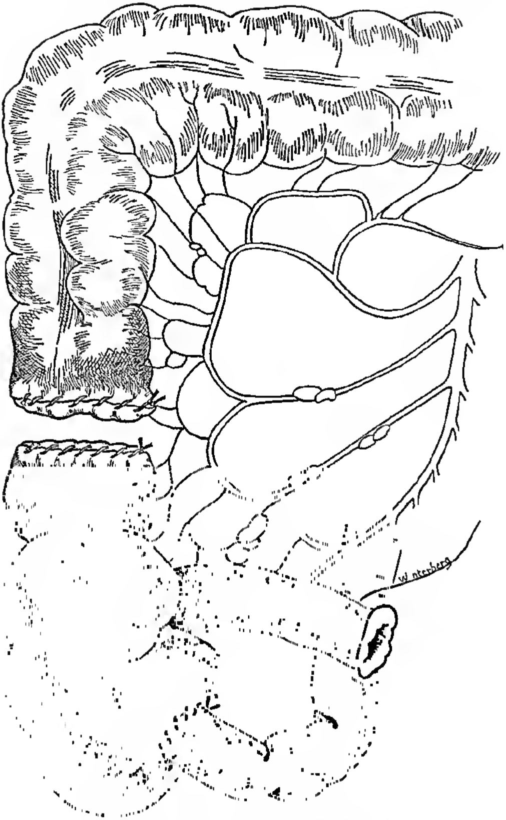


Fig 153 Spivack method of the formation of an artificial anus The cecum is divided transversely and each end is closed blindly

feces. An artificial rectum is formed (from the terminal portion of the ileum). An artificial sphincter ani is formed (from the ileo-cecal valve).

Technic.

The operation is performed as a two-stage method.

FIG. 154. Spivack method of the formation of an artificial anus. Final view.

First Stage.

Step 1. The abdomen is opened on the right side by a "gridiron" incision.

Step 2. The terminal portion of the ileum is cut transversely between two crushing-clamps at a distance of three inches from the ileo-cecal junction.

Step 3. The appendix is removed. The end of the proximal portion of the divided ileum is implanted into the anterior wall of the cecum (Fig. 151). The distal end of the divided ileum is brought outside the abdominal cavity and fastened to the layers of the anterior abdominal wall (Fig. 152).

A few days later the second stage is performed:

Second Stage.

Step 1. The abdomen is opened by a transverse incision which runs

on the right side from the anterior axillary line to the lateral border of the right rectus muscle This incision is made at the level of the umbilicus (Fig 154) After the skin is incised, its lips are retracted, and the abdominal cavity is entered through a muscle splitting incision

Step 2 The cecum and the adjoining portion of the ascending colon are mobilized and brought outside the abdominal cavity Two crushing clamps (Payr or Doyen) are placed across the colon very close to each other, the bowel is cut between the clamps by the cautery Each end of the divided bowel is then closed blindly (Fig 153)

Step 3 The abdomen is closed in layers

The final view is seen in Fig 154

B TEMPORARY COLOSTOMY

The prerequisites for temporary colostomy are the same as for permanent colostomy, and they have already been enumerated in the sub chapter on permanent colostomy In addition to them, temporary colostomy offers some other difficulties, since, in the latter, two of the prerequisites are antagonistic to each other

a In order that the fecal material should not pass into the distal loop it is necessary to make a marked spur The larger the spur, the more assured we are that the contents will not escape into the distal loop

b It is easier to close the opening (when the necessity for it no longer exists) when the bowel does not form a spur If a spur is present, the smaller the spur, the easier it is to close the opening This is the reason why it is such a difficult task to make a truly satisfactory temporary colostomy, and this explains also why so many different methods have been suggested

Technic

Step 1 The same as Step 1 in Left Inguinal Colostomy

Step 2 The same as Step 2 in Left Inguinal Colostomy

Step 3 The proximal part of the sigmoid flexure is drawn outside the abdominal cavity until it is placed on a moderate stretch Care should be taken to see that only part of the intestinal wall protrudes outside of the wound and that no spur is formed

Step 4 The abdominal wall is sutured to the circumference of the sigmoid flexure The needle and the thread pass through the peritoneum and the transversalis fascia only and through the seromuscular layer of the bowel It is best to suture with interrupted stitches placing them at a distance of three fourths of an inch from each other, and penetrating the peritoneum and the transversalis fascia at a distance of one inch from their edges (Fig 118, b) The bowel should be attached to the ends of the abdominal incision in such a manner that the thread penetrates the peritoneum and the transversalis fascia of one lip, then through the seromus-

cular layer of the bowel, penetrating the taenia longitudinalis coli, and then through the peritoneum and the transversalis fascia of the other lip. In this manner, there is no danger of the slipping of a loop of the small bowel between the large bowel and the skin, thereby eliminating the danger of possible incarceration or strangulation of a loop of small bowel.

Step 5. The edges of the peritoneum and of the transversalis fascia are sutured to the edges of the skin of the same lip. Thus, the thickness of the abdominal wall will be sealed and the chance of its contamination by intestinal contents will be greatly minimized (Fig. 119).

Second Stage.

The second stage is done four or five days after the first stage.

Step 6. A longitudinal incision, about one and a half inches in length, is made along the free (antimesenteric) border of the proximal portion of the bowel.

If, however, the patient has severe "gas-pains," immediately after the operation, or if it is necessary to open the bowel within twenty-four hours after performing the first stage, then a glass tube should be inserted in the manner already described.

However, we prefer, if possible, not to suture the bowel to the peritoneum.

The appendix and cecum are used quite frequently as the seat of the colostomy opening. The performance of cecostomy in the case of intestinal obstruction dates back to the year 1776, when Pillore, of Rouen, performed it on a patient suffering from cancer of the rectum.

Appendicostomy as a type of colostomy was first suggested in 1884, by C. B. Keetley, at a meeting of the London Medical Society, when he "suggested that when it was necessary to empty the cæcum at once, the vermiform appendix might be made use of as a spout." The first who actually utilized this idea of Keetley was R. F. Weir, who reported, in 1902, that he performed appendicostomy. He, evidently, was not aware of the suggestion of Keetley. In 1909, Groves performed an appendicostomy as one of the important steps in the treatment of peritonitis accompanying a ruptured appendix. However, in recent years this operation has not been used frequently for treatment of peritonitis after a ruptured appendix. For the latter condition the surgeons are now using Wangensteen suction method and administration of sulfa drugs, penicillin and intravenous infusion or transfusion.

C. APPENDICOSTOMY

Technic.

Step 1. The abdomen is opened by a McBurney incision.

Step 2. The cecum is located. The appendix is found and delivered outside the abdominal cavity. The meso-appendix is clamped close to the tip

of the appendix, which enables the surgeon to secure a firm hold on the appendix The meso-appendix is ligated A purse-string suture is placed on the cecum half an inch away from the base of the appendix The appendix is clamped close to its base by two clamps, and is removed by an incision made between these two clamps The forceps, clamping the base of the appendix is now replaced by two or three Allis forceps each of which grasps the edge of the appendicular stump A catheter No 14F is introduced into the cecum through the patent appendicular stump A bite is inserted now through the wall of the appendicular stump and the wall of the catheter, thus fastening the catheter The latter is now invaginated, thereby inverting also the appendicular stump The ends of the purse-string are tied and cut short

Step 3. The catheter is brought outside the abdominal cavity either through the original abdominal incision or through a stab-wound In the latter case the original incision is closed

D CECOSTOMY

The first cecostomy, as already mentioned, was performed by a Frenchman, Pillore, of Rouen, in 1776, to relieve a patient from intestinal obstruction due to carcinoma of the rectum It is employed now for all cases of obstruction of the ascending colon, and by some surgeons also for obstruction of the transverse and even the descending colon Some surgeons are also using it as a routine procedure in the treatment of ruptured appendix with ensuing general peritonitis The technic employed may be either as in the Stamm or Witzel methods of gastrostomy

E CLOSURE OF AN ARTIFICIAL ANUS

The technic of closure of an artificial anus differs according to whether we are dealing with a temporary or a permanent colostomy In the first case, it is simpler because, while performing the colostomy, every effort was made to facilitate its closure at some future time Whereas in the case of a permanent colostomy its closure was not contemplated at all at the time when the operation was done and, as a matter of fact, every effort was made at that time to prevent ultimate closure of the opening

I Closure of a Temporary Colostomy.

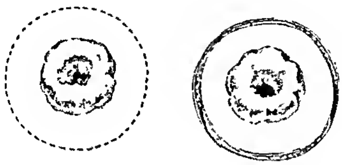
Step 1. The edges of the opened end of the bowel must be refreshed

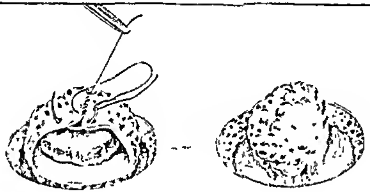
Step 2. The opening is closed by over-and-over sutures either by penetrating symmetrical points of the opposite lips, or by uniting the upper angle of the opening with the lower, and then suturing the symmetrical points of the newly formed lips The over and over layer is reinforced by a seromuscular layer of sutures

Step 3. The adhesions formed between the bowel and the abdominal

wall are separated, and the lips of the abdominal wound, except the skin, are sutured to each other.

Step 4. The skin-lips are sutured together.





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II. Closure of a Permanent Colostomy.

The main difficulty in repairing an artificial anus is to destroy the spur. This was described as the 3rd Stage of the Mikulicz operation. As soon as this is done, the remainder of the operation is merely a simple closure of a temporary colostomy.

An over cautious surgeon who fears to crush the spur on account of the possibility of crushing some intestinal loop may adopt the following technic

Step 1 An elliptical incision is made around the artificial anus penetrating the skin and superficial fascia only This incision should lie at a distance of one or one and one half inches away from the edges of the opening (Fig 155, upper half) The inner flap is reflected up to the colostomy opening and the edges of this flap are sutured together so that they entirely cover the colostomy opening (Czymanoffsky technic Fig 155, lower half)

Step 2 The limbs of the bowel which form the artificial anus are detached from the anterior abdominal wall

Step 3 The portion of the sigmoid which forms the artificial anus is resected in the same manner as described in "Resection of the Sigmoid Colon," and the continuity of the intestinal tract is restored either by an end to end, an end to side, or a lateral intestinal anastomosis

Step 4 The abdomen is closed

F CLOSURE OF A FECAL FISTULA

When a fecal fistula is the result of some pathological change in the bowel or of a surgical accident its closure becomes a complicated procedure In many cases dense adhesions are formed before the surgical interference takes place The skin is the seat of a severe dermatitis or eczema, and this makes the intervention still more complicated These are the reasons why many surgeons advocate always attempting the closure by injecting different kinds of paste into the fistulous tract with the aim of ultimate spontaneous closure However, if the mechanical means fail, one must resort to surgery

As there are many forms of fistulæ, depending on their location and etiology, there can hardly be outlined a single operative procedure which will satisfactorily take care of all the cases However, a few general facts should be remembered Care should be taken to diminish the irritation of the skin (The care of the skin is a very important feature in the pre operative management) Attempts should never be made to close the fistula by operating upon the skin-opening It is advisable to open the abdomen some distance from the fistula in order to reach the bowel-end of the fistula This end of the fistula is cut, and the opening in the bowel is closed in two layers—the first, over and-over, and the second, sero muscular Then an attempt is made to follow the fistula and dissect it out, If, however, this is difficult on account of dense adhesions, it may be left alone, since being disconnected from the bowel it will eventually close spontaneously

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PART II

CHAPTER IX

ANATOMY OF THE STOMACH. ITS STRUCTURE, NERVE- AND BLOOD-SUPPLY. ITS LYMPHATIC DRAINAGE

The stomach is the most dilated portion of the gastro-intestinal tract Its form and position present great variations not only in different individuals but even in the same individual, depending to the degree to which it is filled, the size and the position of the adjacent organs, etc Much light on the size, the position and the form of the stomach has been thrown by X-Ray examination, which altered many previous conceptions concerning them in the living individual

Shape: Generally it is piriform

Size: This varies according to the degree of distention In a fully distended stomach, the length is ten to eleven inches, the width four to four and one-half inches, its antero-posterior diameter three to four inches, the average capacity about two and one-half pints, and its weight about four and one half ounces

The stomach has two surfaces

a The anterior b The posterior

Two borders

a The greater curvature, and b The lesser curvature

The stomach is divided into four portions

a. The cardia **b** The fundus **c** The body proper **d.** The pylorus (Fig 156)

Position of the Stomach

It lies in the epigastric and left hypochondriac regions

The cardia lies about four inches behind the sternal end of the seventh left costal cartilage, about one half to one inch to the left from its junction with the sternum From the posterior aspect of the body, the cardia lies at the level of the tenth thoracic vertebra

a. The cardia is the esophageal opening into the stomach To the left side of the cardia is the **incisura cardiaca** which separates it from the fundus

b. The fundus is the uppermost portion of the body It is usually filled with gas It lies in the left hypochondrium and its dome reaches the level of the sternal end of the left fifth costal cartilage

c. The body of the stomach extends to the angular notch on the small

curvature and to the notch on the greater curvature at which the pylorus starts.

d. The pylorus begins at the angular notch of the lesser curvature and at the notch on the greater curvature and extends to the beginning of the duodenum.

The pylorus itself is subdivided into a larger portion, the antrum, and a smaller tubular portion adjoining the duodenum, the pyloric canal.

The pylorus lies near or on the median line of the body and at the level of the first lumbar vertebra. In the distended stomach, it lies one to one and one-half inches to the right of the middle line. Its position on the surface of the anterior abdominal wall corresponds to a point one-half inch to the right from the midline at the level of a line drawn around the body midway between the jugular notch of the sternum and the symphysis pubis (Addison line).

Structure.

The wall of the stomach consists of four layers:

a. The tunica serosa. b. The tunica muscularis. c. The tunica submucosa. d. The tunica mucosa.

a. **The tunica serosa.** This is peritoneum corresponding to the visceral peritoneum of the bowel, and consists externally of endothelium which rests on a fibro-elastic layer, which is attached to the next layer, the tunica muscularis.

b. **The tunica muscularis.** This consists of three layers, an external layer of longitudinal fibers, a middle layer of circular fibers, and an inner layer of oblique fibers.

c. **The tunica submucosa.** This consists of a layer of connective tissue. It contains the blood-vessels, lymphatics and nerves (the plexus of Meissner). These pass into and subdivide in the mucosa.

d. **The tunica mucosa.** This is a dense layer which is thickest near the pylorus. Its surface is much larger than that of any other layer of the stomach, and, therefore, it is plicated and forms numerous folds or ridges which, during distention of the stomach, are completely effaced. These folds run mostly in a longitudinal direction, especially near the pyloric end of the stomach.

The glands of the stomach are situated in the mucosa and are of two varieties: the fundus glands and the pyloric glands.

The fundus glands lie in the fundus and the body, including the region of the lesser and the greater curvatures.

The pyloric glands lie in the pyloric region.

The fundus glands secrete hydrochloric acid; the pyloric glands secrete mucus (Bensley).

THE BLOOD-SUPPLY OF THE STOMACH (Figs 156 and 157)

This is derived from the three terminal branches of the celiac artery:

a. The left gastric artery.

b. The hepatic artery.

c. The splenic artery.

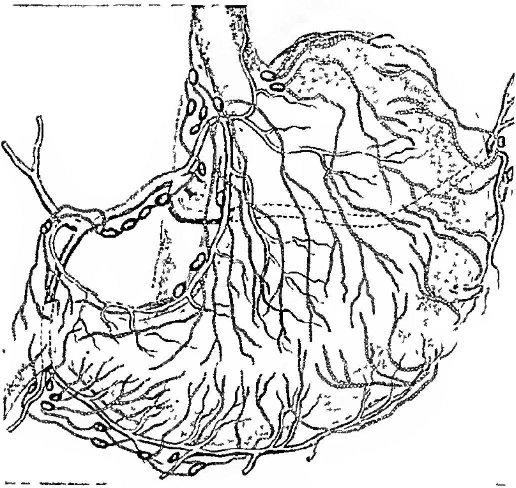

Fig 156 Arteries and lymphatics of the stomach Anterior view (after Polya and von Navratil)

a. The left gastric artery takes its origin from the celiac artery and runs upward and to the left. Then it makes a curve, pierces the left gastro-pancreatic ligament, and runs along the lesser curvature between the two layers of the lesser omentum Before piercing the left gastro-pancreatic ligament, it gives off an esophageal branch which inosculates with the lowest of the esophageal branches of the thoracic part of the aorta

The left gastric artery in its course along the lesser curvature inosculates with the right gastric artery, which is a branch of the hepatic

artery, so that these two arteries form, as it were, a single artery which runs along the lesser curvature. From this single trunk six to eight branches take their origin, and some of these run across the anterior, and others across the posterior wall of the stomach.

FIG. 157. Arteries and lymphatics of the stomach. Posterior view (Polya and von Navratil).

b. The hepatic artery takes its origin from the celiac artery and runs transversely to the right. On its way it pierces the right gastro-pancreatic ligament and then changes its course to an upward direction and finally breaks into a right and left hepatic artery. Before thus dividing, it gives off two branches:

1. The gastro-duodenal artery, which runs behind the first portion of the duodenum to its lower border where it breaks into two terminal

branches, the right gastro-epiploic artery and the superior pancreatico-duodenal artery

2 The right gastric artery, which runs along the right side of the lesser curvature to the left, where it inosculates with the left gastric artery as described above

The right gastro-epiploic artery runs along the greater curvature from right to left and inosculates with the left gastro-epiploic artery, which is a branch of the splenic artery These two gastro epiploic arteries form, as it were, a single artery which runs along the greater curvature of the stomach and which gives off four or five branches to each wall of the stomach These vasa brevia anastomose with each other and with the short arteries (vasa brevia) derived from the right and the left gastric arteries

c The splenic artery is the largest branch of the celiac artery It runs at first behind the stomach, then behind the gastro-splenic ligament until it reaches the spleen On its way it gives off branches to the fundus and to the upper part of the body of the stomach, and finally the left gastro epiploic artery which, as already mentioned, inosculates with the right gastro epiploic artery (Figs 156 and 157)

THE LYMPHATICS OF THE STOMACH

An accurate knowledge of the lymphatic drainage of the stomach is essential if the operative treatment of malignant disease occurring therein is to be attended with any degree of success

The lymph vascular and lymph glandular arrangements in and around the stomach have been studied by many observers among whom should be mentioned Cunéo, Most, Borrmann Lengemann, Polya and von Navratil, and Jamieson and Dobson

To Mikulicz is due the credit of being the first who demonstrated the principles and the methods upon which the rational operative treatment of cancer of the stomach must be based The investigations of Most, Borrmann, and Lengemann were made in his clinic

The lymphatic system of the stomach consists of lymph-vessels and lymph glands According to Cunéo, the stomach may be divided into three parts, according to the direction of the lymph flow A line drawn from the apex of the fundus to the middle of the pyloric canal divides the stomach into the upper and the lower portions

The direction of the lymph-vessels of the upper portion is parallel to the lesser curvature The portion of the stomach below this line may be subdivided by a perpendicular line drawn from the left side of the cardiac opening to the greater curvature

The course of the lymph-vessels of the left portion of this divided lower portion of the stomach is toward the left gastro-epiploic artery, and of the right portion is toward the right gastro-epiploic artery

The lymphatic vessels all drain into the lymphatic glands, which are arranged in certain groups. As the glands follow closely the course and the distribution of the blood-vessels, they bear the same names as the blood-vessels.

Therefore, the glands in this region are associated with:

A. The left gastric artery.
B. The hepatic artery.
C. The splenic artery.
D. The celiac artery.

A. THE GLANDS ASSOCIATED WITH THE LEFT GASTRIC ARTERY

a. The lower coronary (Jamieson and Dobson), or the anterior left gastric glands.

b. The upper coronary (Jamieson and Dobson), or the posterior left gastric glands.

c. The paracardial glands.

a. The lower coronary or the anterior left gastric glands. These glands lie along the left half of the lesser curvature in close proximity to the left gastric artery and between the leaflets of the gastro-hepatic omentum. They extend to the right paracardial gland, and receive their afferent vessels from the entire length of the lesser curvature. The number of these glands is variable. Polya and von Navratil found on an average only two or three. Their efferent vessels discharge into the posterior left gastric glands.

b. The upper coronary or the posterior left gastric glands. This group lies along the main trunk of the left gastric artery at the point where the artery pierces the left gastro-pancreatic ligament. They are the most constant and the most important glands of this region. Their afferent lymph-vessels run from the anterior left gastric gland group and from the right, left and posterior paracardial glands.

In addition, they receive, as Polya and von Navratil pointed out, the afferent vessels from the lesser curvature of the stomach. [This observation is one of great significance from the surgical point of view.] Their efferent vessels drain into the celiac glands.

c. Paracardial glands. Some authors subdivide these into two groups, the right and the left, while others subdivide them into three groups, the right, the left, and the posterior paracardial glands. The paracardial glands, together with their lymphatics, form a "girdle," an expression coined by Most. The right paracardial glands are constant. They receive their afferent vessels directly from the lesser curvature of the stomach and from the retro-paracardial and left paracardial glands (Polya and von Navratil). Their efferent vessels drain into the posterior left gastric glands. The left paracardial glands, according to Cunéo, are not as constant as the right

paracardial glands Polya and von Navratil and Jamieson and Dobson consider them as constant glands Their afferent vessels come from the fundus, and their efferent vessels drain into the upper coronary (the posterior left gastric) glands **The posterior paracardial glands** lie on the posterior aspect of the stomach between the layers of the gastro phrenic ligament Their afferent vessels come from the neighboring portion of the cardia, and their efferent vessels drain into the posterior left gastric glands

B THE GLANDS ASSOCIATED WITH THE HEPATIC ARTERY

These may be subdivided into three groups

a Those in connection with the gastro-duodenal artery

b Those in connection with the trunk of the hepatic artery

c Those in connection with the pyloric artery

a The glands in connection with the gastro duodenal artery are subdivided into three groups

An upper group, lying near the bifurcation of the gastro duodenal artery

A lower group, lying along the right gastro epiploic artery below the greater curvature of the stomach

A retropyloric group lying along the side of the gastro duodenal artery behind the pylorus

The "upper" and "lower" groups are termed "subpyloric" by Polya and von Navratil Jamieson and Dobson term only the "upper" group as "subpyloric"

The "upper group" or the "subpyloric" (J and D) consists of four or five glands and occasionally more, lying beyond the pylorus at or near the point of bifurcation of the gastro-duodenal artery They lie in the angle formed by the first and second portions of the duodenum Their afferent vessels come from the pylorus and duodenum, and they receive also the efferent vessels from the "lower group" Their efferent vessels run in three directions

1 To the glandular chain along the hepatic artery

2 Across the pancreas to the glands of the celiac artery

3 To the glands lying in the root of the mesentery

The "lower" group, two to seven in number, lie along the right gastro-epiploic artery between the layers of the great omentum They lie below the artery and are apt to wander downward into the great omentum Their afferent vessels drain the lower third of the stomach along the right half of the greater curvature, and their efferent vessels discharge into the glands of the upper group

The retropyloric glands, inconstant, lie behind the pylorus on the anterior surface of the pancreas beside the gastro-duodenal artery Their afferent vessels come from the "upper" group and also directly from the posterior surface of the pylorus and the duodenum

b. The glands in connection with the main trunk of the hepatic artery (the right suprapancreatic glands).—These glands are few in number and lie along the trunk of the hepatic artery at the upper border of the pancreas. Their afferent vessels drain the region of the upper border of the pylorus (occasionally, a "suprapyloric" gland lies in the path of one or more of the vessels). They receive also the efferent vessels of the "upper gastro-epiploic" group. These glands are, therefore, both primary and secondary. Their efferent vessels drain into the glands around the celiac artery.

C. THE GLANDS ALONG THE SPLENIC ARTERY

The glands drain the "isolated" area of the stomach. Only one or two small glands of this group lie in the hilum of the spleen and in the gastrosplenic omentum. The main group lies along the trunk of the splenic artery at the upper border of the pancreas, and these are called the suprapancreatic glands. They receive their afferent vessels from the left half of the greater curvature and from the fundus, and their efferent vessels run into the glands of the celiac artery.

D. THE GLANDS IN CONNECTION WITH THE CELIAC ARTERY

These glands are few in number but large in size. They lie beside the celiac artery between the origin of the left gastric and splenic arteries. They are recipients of all the groups of glands previously mentioned. Their efferent vessels discharge partly into the receptaculum chyli and partly run behind the pancreas to the glands lying in the root of the mesentery.

As may be seen from the above description, there are two different groups of glands: One group receives its vessels directly from the stomach and constitutes the "primary" group of glands. Another group receives its afferent lymphatics from the glands of the first group and they constitute the "secondary" group. There are certain groups which are both "primary" and "secondary."

From the surgical point of view, it is extremely important to differentiate the "primary" from the "secondary" glands. Thus, in case of cancer of the stomach the "primary" glands are, or may be, very early involved. In partial gastrectomy, this first cordon of glands should be removed. These glands are:

1. The lower coronary (O. T.) or the anterior left gastric group (B. N.).
2. The upper coronary (O. T.) or the posterior left gastric group (B. N.).
3. The right paracardial group.
4. The suprapyloric group.
5. The right suprapancreatic group.
6. The gastro-epiploic (the upper and the lower) group.
7. The retropyloric group.

Glandular invasion occurs early in cancer of the stomach According to Cunéo, this was found to be correct in all cases in which an autopsy was performed, and in 87 5 per cent of the specimens removed by gastrectomy An invasion of the glands of the lesser curvature is most frequently found According to Cunéo, this is present in 91 4 per cent of all the cases, and the glands on the greater curvature are affected in 62 5 per cent

THE NERVE SUPPLY OF THE STOMACH

The nerve supply of the stomach is derived both from the central and the sympathetic nervous systems The right and the left vagus nerves represent the central system, and branches coming from the sympathetic celiac represent the sympathetic system Both vagi nerves pass through the esophageal opening of the diaphragm, the left vagus nerve ramifying on the anterior wall and the right on the posterior wall of the stomach

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CHAPTER X

GASTROTOMY

The word "gastrotomy" consists of two Greek words: γαστήρ, stomach and τέμνειν, to cut. It means "to cut the stomach." This term is applied to cases in which the opening and the closure of the stomach is done in one sitting.

This is the earliest of all gastric operations, and was first performed by Dr. Daniel Schwaben, in 1635, on a farmer who accidently swallowed a knife. The patient survived the operation. However, the stomach was not closed and a fistula formed, so instead of intended gastrotomy it became a gastrostomy.

Indications.

1. Removal of foreign bodies from the stomach.
2. Removal of foreign bodies from the lower end of the esophagus.
3. Dilatation of the lower end of the esophagus.
4. Exploration of the interior of the stomach in case of bleeding gastric ulcer.
5. Removal of a polypus projecting into the lumen of the stomach.
6. Checking of a hemorrhage from the suture line of a previously performed gastro-enterostomy or partial gastrectomy.

Technic.

Step 1. The abdomen is opened through a longitudinal or a transverse incision.

Step 2. The omentum is grasped and gently drawn down. Thus, the anterior wall of the stomach is brought into view. The assistant catches the anterior wall of the stomach in two places close to the greater curvature. [The stomach should never be held with gloved fingers, because it will slide and made it a very difficult task for the assistant to hold it. The stomach should always be held with a piece of gauze in each hand. This gauze should always be moistened in warm normal salt-solution.] The anterior wall of the stomach is walled off by four laparotomy sponges, placed one to the left, another to the right, the third above and the fourth below the intended line of the incision of the anterior stomach-wall. A laparotomy sponge with a hole in its center is placed on the anterior wall of the stomach in such a manner that the hole corresponds to the intended line of incision. (Fig. 158, insert). This sponge is held attached to the stomach by two Allis forceps. The assistant now holds the stomach by holding these two Allis forceps.

Step 3 An incision is made through the seromuscular layer of the anterior wall of the stomach The mucosa, which will then protrude is caught by an Allis forceps and put on the stretch It will then acquire the form of a cone This is cut by scissors just below the point where the Allis forceps holds the mucosa (Fig 158) The tube of a suction apparatus is

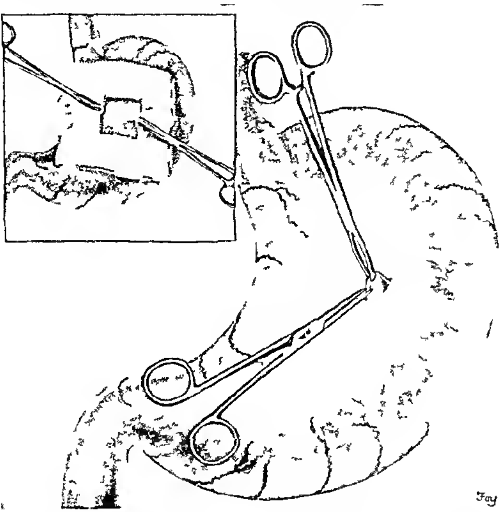

FIG 158 Gastrotomy *Insert*—A portion of the stomach is isolated *Main picture*—Scissors ready to cut the anterior stomach wall

introduced into the lumen of the stomach and its contents sucked out The incision of the stomach is then enlarged so that the proper examination of its lumen becomes possible (Fig 159)

Step 4 The operation within the lumen of the stomach is performed according to the conditions for which the gastrotomy was indicated

Step 5. The stomach-opening is closed by over-and-over sutures reinforced by a layer of seromuscular sutures, continued or interrupted.

Step 6. The abdomen is closed.

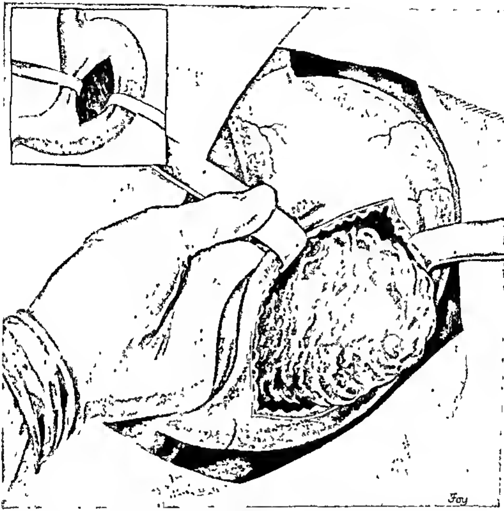

Fig. 159. Gastrotomy. *Insert*—The lips of the incised anterior gastric wall are retracted. *Main picture*—The posterior wall is delivered through the incision in the anterior wall.

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CHAPTER XI

GASTROSTOMY

Definition.

The word "*gastrostomy*" is derived from two Greek words γαστηρ, stomach and στομα, mouth It signifies a "gastric fistula," which connects the lumen of the stomach with the outside world

Indications

Gastrostomy is performed

A For the purpose of feeding the patient through the stomach-opening when for some reasons the esophagus cannot be used for this purpose

B For some therapeutic purposes

A The usual cases which prevent feeding through the esophagus are

1 Constriction of the esophagus due to benign or malignant tumors

2 Constriction of the esophagus due to the healing of ulcers produced by swallowing corrosive material

3 Constriction of the esophagus which occurs from time to time after deep X-Ray therapy of the neck This therapy is employed in case of malignancy of some of the structures of the neck, such as the larynx or the thyroid

4 Diverticuli of the esophagus, when part of the food passes into the diverticulum, stagnates there and produces esophagitis In order to control the inflammation, it is best not to feed the patient through the mouth

5 Aneurysm of the aorta which compresses the esophagus

6 Tumors of the posterior mediastinum

B For therapeutic purposes, the gastrostomy is performed in those cases in which it is desired to dilate the cardiac end of the stomach and also occasionally for gastroscopy and duodenoscopy

Historical

Cases of gastric fistula have been known since the seventeenth century In 1635, Daniel Schwahen operated on a man who accidentally swallowed a knife He removed it through a very small gastric incision which did not need, according to the opinion of the surgeon, to be closed He sutured only the skin with five peg sutures, so that there was escape of gastric contents to the outside

Cases of gastrostomy produced by trauma were known long before it was suggested as an operative procedure by Egeberg Thomassin, whose paper appeared in 1791, stated that Joubert preserved the stomach of a man who had a gastric fistula for many years This man was taking food

through this opening and enjoyed good health for a long time. Several other cases of gastric fistula of traumatic origin were reported in the eighteenth and in the early part of the nineteenth centuries. In one of such cases the fistula was open for ten and in another for twenty-seven years. The most celebrated case of this kind was that of the Canadian trapper Alexis San Martin who, in 1822, sustained a gunshot wound of the abdomen with formation of a gastric fistula; it became the object of study by W. Beaumont and was described in his epoch-making paper in 1833. As a planned operation, a gastric fistula was first suggested by Christian A. Egeberg, a Norwegian military surgeon, who on May 8, 1837, presented a paper before the Christiania Medical Society. This was published by Johan Hjort in 1841. It is a remarkable paper not only because a new operation was suggested, but also because Egeberg gave an outline of the technic the essential features of which were preserved by many surgeons for half a century.

Bassow of Russia, in 1842, performed eight gastrostomies on dogs and Blondlot of France, in 1843, also on dogs. However, Pétel, a surgeon of Cateau, was the first of the French surgeons who suggested this operation in 1843 and Watson of New York in 1844.

The first who performed it on a human being was Sédillot of Strassbourg, who performed his first operation in 1849 and the second in 1853. He coined the expression "fistulous gastrotomy" which he later replaced by "gastrostomy" also coined by him. In his second case he used a metallic canula and covered it with a cap, to prevent the escape of gastric contents.

After that this operation was done in different countries. The first case in Denmark and the third on record was done by E. Fenger of Copenhagen in 1853. He was the first to introduce the left oblique abdominal incision running parallel to the left costal arch and which is known as "Fenger incision."

In England the first gastrostomy was done in 1858 by J. Cooper Forster; in Germany by Van Thaden, of Kiel, in 1866; in United States by F. F. Maury of Philadelphia in 1869; and in Russia by N. W. Sklifassofski in 1879.

The first successful gastrostomy is usually attributed to Sydney Jones of London, whose patient, operated in 1875, lived forty days following the operation.

The first successful case in France was done by Verneuil in 1876 on a 17 year old boy, who swallowed corrosive material. In Germany the first successful gastrostomy was performed by Schoenborn in 1876, whose patient died three months after operation. Some writers unaware of Schoenborn's case attributed the first successful gastrostomy in Germany to Trendelenburg, who operated in 1877 on an eight year old boy, who swallowed corrosive material. The child recovered.

Several difficulties confronted the surgeons of those days, among which the most important were leakage of gastric contents and peritonitis. Among other complications arising from time to time was the detachment of the stomach from the abdominal wall and slipping back into the peritoneal cavity, transverse colon occasionally was mistaken for the stomach and colostomy was done instead of gastrostomy. All these difficulties were overcome in a comparatively short time with exception of leakage of gastric contents. Many ingenious devices were offered to overcome this difficulty. All these methods can be classed into several groups.

Classification of Methods

All the procedures described can be grouped into several classes.

I FORMATION OF A GASTRIC CONE THE BASE OF WHICH IS ATTACHED TO THE ABDOMINAL WALL

This is the oldest method of gastrostomy. It is characterized by pulling out a small gastric cone and suturing its base circularly to the parietal peritoneum. The opening into the stomach was made at the apex of the cone either at once, thus constituting a one stage gastrostomy, or a few days later, thus constituting a two stage gastrostomy.

The surgeons relied for watertightness of the stomach upon the contractibility of the muscles of the gastric wall and on redundance of the gastric mucosa plugging the gastric opening. By this method it was done by Sédillot, Fenger and other pioneers in gastrostomy. It is worth mentioning that Sédillot in his second case operated in 1853 after opening the stomach introduced a metallic canula and closed it with a cap in order to prevent escape of gastric contents. In other words Sedillot is the originator of "Canula Methods" in gastrostomy. If, however, the opening of the stomach was made large or if the mucosa was not redundant, the contents escaped and several modifications of the "gastric cone" method were introduced to check the leakage.

1 Utilization of the m rectus as a sphincter compressing the cone. This compressor factor serves as an additional aid to previously mentioned factors in making the stomach watertight. However, even then, it did not always accomplish this aim.

a Method of von Hacker. Described in 1886.

It consists of carrying a cone of the anterior gastric wall through the split fibers of the left m rectus abdominis. It was hoped that these fibers will compress efficiently the gastric cone and make the stomach watertight. However, it did not prevent leakage.

Though this method is usually credited to von Hacker, it was done long before him. Troup had operated by this method in 1867, Maury in 1869, Schoenborn in 1878.

b. Girard method. Described in 1888.

He opened the abdomen longitudinally by a left midrectus incision, split a portion of this muscle on each side of the opening, making on each side a muscular band 2 cm. wide and 10 cm. long. He lifted then these band-like portions and crossed each with the other at their extremities so as to form a sphincter and fixed the ends in such position by suturing. Next, a gastric cone was brought outside the abdomen through this sphincter, the base of which was sutured to the muscle circularly; the apex of the cone was opened and a rubber tube inserted.

2. **Utilization of cartilages of adjoining ribs as a stop-cock** (Hahn method).

The abdomen is opened and a portion of the anterior gastric wall is selected; this is carried outside through another opening made between the cartilages of the left 8th and 9th ribs. The abdominal incision is closed. He expected these cartilages to act as a stop-cock.

3. **Carrying of the gastric cone along oblique channel through muscles, fascia or under the skin.**

This principle of forming a tortuous instead of a direct canal is one of the most effective methods of preventing leakage.

a. Ssabanejev method and its modifications (Jaboulay, Lucy).

The description of this method is given farther on in the chapter.

b. Hartman method. Described in 1897.

The abdomen is opened by a left paramedian incision and a gastric cone is brought outside the peritoneum, then carried laterally behind the m. rectus, then brought anteriorly through the m. rectus split in its middle third, so that the skin opening is about 2½ cm. to the left of the midline. Thus the fistulous tract is compressed at two places: between the m. rectus and its posterior sheath and between the fibers of the left m. rectus abdominis.

4. **Torsion methods, in which the gastric cone is rotated axially.**

a. Ullmann method. Employed in 1894.

The gastric cone is brought outside the abdominal cavity and torsion of 180° is made; the base of the twisted cone is then sutured to the parietal peritoneum.

The apex of the cone is then opened and the lips are sutured to the skin.

b. Souligoux method. Published in 1902.

It consists of twisting the cone twice: the first is made at 180° as soon as the stomach is brought outside the abdominal cavity and the base of the twisted cone is then sutured to the parietal peritoneum; another twist at 120° is made and the cone sutured to the anterior sheath of the m. rectus; the apex of the cone is then opened and the lips are sutured to the skin.

c. Helferich method. Described in 1895.

This is a combination of the Ssabanejev and Ullmann methods The operation is done exactly as in Ssabanejev's method with this difference only that the apex of the gastric cone brought outside the small subcutaneous opening on the chest wall is twisted at 180°, then opened and sutured with the lips of the skin

II FORMATION OF A CHANNEL FROM THE ANTERIOR GASTRIC WALL

The general principle of this group consists of making a channel from the anterior gastric wall which is lined with serosa Whereas this method adds to the watertightness of the stomach, it introduces an objectionable feature namely, the channel lined with a serosa has a tendency of obliteration This general group can be subdivided into several sub groups

1 Formation of a channel by doubling a portion of gastric wall over a rubber tube The channel lies horizontally and parallel to the anterior abdominal wall

a Witzel method Described in 1891

The description of this method is given farther on in the chapter

b Gernez modification Described in 1929

The description of this modification is given farther on in the chapter

2 Formation of a channel by invagination of the gastric cone by a purse string suture (Stamm) or by Lembert suture (Kader, Fontan) The channel lies vertically and the opening into the stomach is at its bottom

a Stamm method Described in 1894

The description of this method is given farther on in the chapter

b Kader method Described in 1896

The description of this method is given farther on in the chapter

c Fontan method Described in 1896

The abdomen is opened a gastric cone is drawn outside the abdomen and its base sutured circularly to the parietal peritoneum The apex of the cone is then grasped by a forceps and the cone is invaginated like a finger of a glove with the forceps being used as an axis The contacting crests of the fold on each side of the forceps are sutured to each other by a series of interrupted sutures after which the forceps is withdrawn A knife is introduced into the channel where before was the forceps and an opening leading into the stomach is made at the bottom through which a rubber tube is introduced into the lumen of the stomach, this tube is fixed to the stomach at the upper end of the channel

Comparing these three methods (Stamm Kader, Fontan) we see that they are identical In each method there is a vertical channel lined with serosa at the bottom of which is the opening leading into the stomach The minor technical differences are that Stamm forms the channel by a purse string suture Kader does this by a horizontal suture and Fontan by a vertical Lembert suture The priority belongs to Stamm

III. INTRAMURAL METHODS

The characteristic feature of this group is that a channel is formed in the thickness of the gastric wall through which a catheter passes into the lumen of the stomach. It was hoped by originators of this group that the channel would not obliterate because it is not lined with serosa and that it will be watertight on account of obliquity of the channel running in the thickness of the gastric wall.

However, these methods did not prove efficient, as in all of them, with the exception of Andrews', the lumen of the channel is not lined with mucosa and, therefore, still retains the tendency to obliterate. The method of Andrews overcomes this tendency because it is lined with mucosa. In the time of its publication in 1894 it was the most efficient though technically the most complicated method. However, the tubular methods and particularly Spivack's tubovalvular method accomplished the same in a simpler way. To this group belong the methods of E. Andrews and E. Wyllys Andrews, Fisher, Marwedel, Schnitzler and Soresi.

a. Marwedel's method.

The description of this method is given farther on in the chapter.

b. Schnitzler method. The description of the method is given farther on in the chapter.

IV. UTILIZATION OF ALREADY EXISTING TUBULAR STRUCTURES IN THE ABDOMINAL CAVITY LINED WITH MUCOSA

To this group belong the method of Tavel who utilized a jejunal loop and Kelling who used a loop of transverse colon. This group has no advantages over the previous one; as a matter of fact they are not as watertight and technically they are more complicated.

Tavel method. Described in 1906. Description of this method is given farther on in the chapter.

V. TUBULAR METHODS IN WHICH A TUBE IS FORMED FROM A FLAP OF A GASTRIC WALL

A common feature to all these methods is that the tube is lined with mucosa and for this reason does not obliterate. These methods depend for their watertightness on the sphincteric action of the abdominal wall muscles and on the size of the mucosa which blocks the base of the tube. The weak point of this group is that in making the tube the compressing action of the gastric wall which contributes to watertightness is lost.

Among the variations of this group should be mentioned the following:

a. Depage method. Described in 1901. The description of this method is given farther on in the chapter.

b. Janeway method. Described in 1913. The description of the method is given farther on in the chapter.

c. Hirsch method Described in 1911 The description of the method is given farther on in the chapter

VI TUBULAR METHODS IN WHICH THE TUBE IS MADE FROM THE ANTERIOR AND THE POSTERIOR GASTRIC WALLS

a Beck-Carrel method Suggested in 1905

The tube is made from a narrow quadrangular flap, the long sides of which are produced by cutting the anterior and the posterior gastric walls parallel to the greater curvature and the free end by cutting the connecting distal points of the two previous lines The flap is turned orally and a tube is formed The opening leading into the stomach is closed, except a small portion connected with the tube In their original communication Beck and Carrel suggested to bring the tube in front of the chest wall and use it as the lower portion of a prethoracic esophagus However, this method was later employed for gastrostomy purposes and, accordingly, the tube has been brought out through the anterior abdominal wall

The same method was suggested in 1912 by Jianu and it is known by many under this name

However, the priority belongs to Beck-Carrel

VII TUBOVALVULAR METHOD

This is characterized by forming from a gastric flap a tube and a valve at its base The tube is lined with mucosa and does not obliterate, the valve closes the tube at its base thus making the stomach watertight

Attempts to make the stomach watertight were made by surgeons from the time of inception of gastrostomy It is worth mentioning that in many different methods the surgeons who offered their devices called them valves, valvular mechanisms, sphincters or channels using all these words as synonyms In 1853, Sédillot, describing a metallic canula consisting of two parts, called each part of it "a valve" Witzel in describing his method in 1891 compares the channel he built with the ureter and claimed that the stomach is watertight due to the "valvular action" of this channel E Andrews and E Wyllys Andrews, in describing their method in 1894, in which they formed an intramural gastric channel lined with mucosa, say about this channel "The valve of the stomach was in good working order and readily pervious to tubes" Stamm in his method published in 1894 states that the channel he built forms "a double sphincter" or "two sets of valves" Fontan in describing in 1896 his method, which actually is identical with Stamm's method, calls his method "valvular method" In other words in all these methods the authors formed a channel and called it valves

Spivack, in 1929, described the tubovalvular method in which he utilized a portion of the anterior gastric wall to form a valve and a tube, it is constructed in such a manner that the valve is situated at the base of

the tube and closes it hermetically, thus making the stomach watertight. The valve is constructed by doubling a portion of the anterior gastric wall exactly in the same manner as in methods of Witzel, Stamm, Kader, Fontan. But whereas the above mentioned authors transformed the formed cul-de-sac into a channel by making an opening at its bottom leading into the stomach, Spivack leaves this doubled wall intact and utilizes the adjoining portion of the stomach to form a tube. In other words, in methods previously mentioned, the gastrostomy apparatus consists of a channel lined with serosa, in which the valve is reduced to a mere piece of mucosa, whereas in Spivack's method the valve consists of doubled gastric wall and the tube is lined with mucosa.

In order that the valve close hermetically the base of the tube it should be a definite ratio between the sizes of the flap forming the valve and of that of the flap which forms the tube.

If the valve and the tube are built correctly but later the valve shrinks or the tube becomes wider there will be produced a relative insufficiency of the valve with ensuing leakage. The technical details of the operation are given below.

Until recently the most commonly used methods were those of Stamm and Witzel, and they will be described first. Since Spivack described his method it has become the operation of choice with many surgeons.

In addition to those methods, there are several others that are used occasionally in some surgical clinics. Some of these are of interest because the principle of the operation is used in other procedures, although in gastrostomy they are discarded.

THE STAMM METHOD

This was suggested in 1894.

Step 1. The stomach is walled off with towels from the rest of the peritoneal cavity. A seromuscular incision half an inch in length is made on the anterior wall of the stomach. This incision lies midway between the greater and the lesser curvatures (Fig. 160, insert).

Step 2. A purse-string suture is placed around this incision. This is done with the right hand while working to the left and above the incision (Fig. 160), and with the left hand while working to the right and below the incision (Fig. 161). One link of the purse-string chain is left as a large loop. [It is well to remember the rule: In order not to obscure the operative field from the assistants, the posture of the surgeon's body should not be changed, but hands and instruments only should be changed.]

Step 3. The protruding mucosa is caught by an Allis forceps and placed on the stretch so that it will form a cone. Then the mucosa is cut with scissors beneath the Allis forceps (Fig. 161, insert). [It should not be cut with the knife, since even if the knife is very sharp, the blade very fre-

quently, instead of going through the mucosa, slides along its surface and separates the mucosa from the seromuscular layer With scissors the mucosa can be cut with one stroke]

Step 4 As soon as the stomach is opened, the *Allis forceps is lifted* upward This will eliminate leakage of the gastric contents from the open-

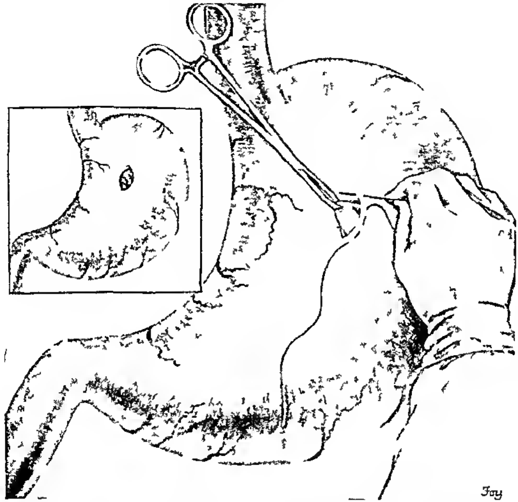

FIG 160 Stamm method of gastrostomy *Insert*—Seromuscular incision on the anterior wall of the stomach *Main picture*—Inserting the purse string suture with the right hand on the left side of the seromuscular incision

ing The tube of a suction apparatus is inserted into the lumen of the stomach and the contents are sucked out A rubber tube, size No 20 of the French scale, one end of which is held by a Kocher forceps, is introduced into the lumen of the stomach for a distance of one inch (Fig 162) The Allis forceps and Kocher hemostat are held together (Fig 163) By this maneuver the rubber tube becomes immobilized and will not slip

downward or upward, which is important in performing the next step. The open end of the rubber tube is clamped by an artery-forceps.

Step 5. The rubber tube is fastened to the stomach-wall by a thread attached to a round curved needle (Fig. 163). The Kocher clamp which holds the rubber tube is now withdrawn from the lumen of the stomach.

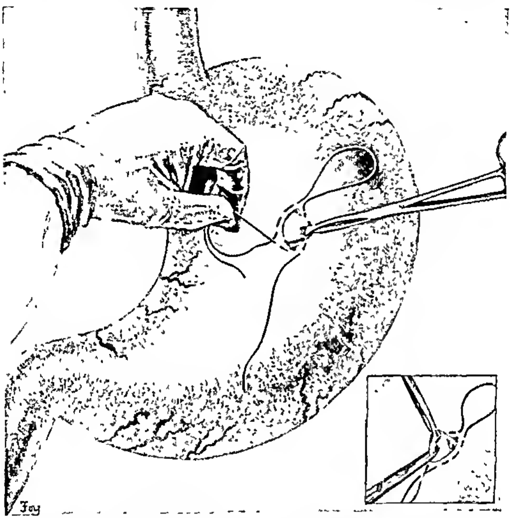

FIG. 161. Stamm method of gastrostomy. Inserting the purse-string suture with the left hand on the right side of the seromuscular incision.

Step 6. The loop which was left in the purse-string is caught with the index-finger of the left hand and its two free ends are held between the thumb and the middle finger of the same hand. The rubber tube is caught with the right hand. The assistant removes the Allis forceps which was attached to the mucosa within the purse-string. By lifting the thread with

his left hand and by pressing down the rubber tube with his right hand, the surgeon thereby invaginates the tube into the stomach wall (Fig 164) By letting the loop drop from his index finger and by continuing to pull the thread upward with his left hand, the rubber tube becomes tightly attached to the stomach The ends are then tied to each other A clamp is

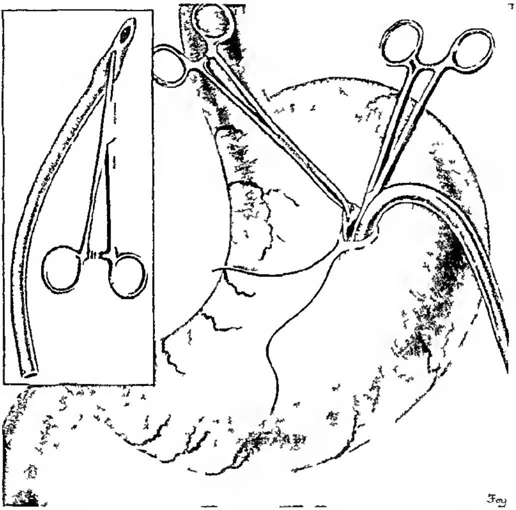

Fig 162 Stamm method of gastrostomy Inserting the catheter into the lumen of the stomach

then placed on the thread and this serves as a good guy suture while another purse string suture is made around the tube (Fig 165)

Step 7 A second purse string suture is made precisely as is described in Step 2 This suture should be at a distance of three fourths of an inch away from the tube The bites should be half an inch apart (Fig 165)

Step 8. The tube is invaginated in the same manner as described in Step 6. The "guy-suture" should be cut short before this invagination is made.

Step 9. The anterior wall of the stomach is fastened to the anterior abdominal wall at two places in the following manner: A round curved

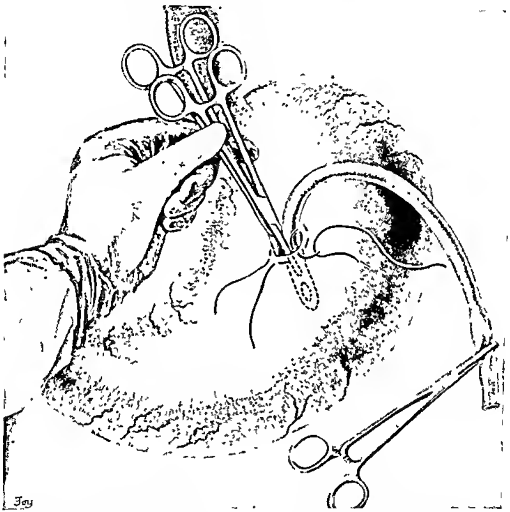

Fig. 163. Stamm method of gastrostomy. Immobilizing the catheter by holding the Allis and the Kocher forceps together while the transfixing suture is inserted through the tube and the stomach-wall.

needle takes a bite through the posterior sheath of the rectus muscle and the peritoneum of one lip of the anterior abdominal wall. Then it pierces the seromuscular layer of the stomach just above the tube. Then the needle passes through the peritoneum and the posterior sheath of the rectus muscle of the other lip of the abdominal wall, and the ends are tied and cut short.

Step 10. The stomach is fastened to the anterior abdominal wall below the tube precisely in the same manner as described in Step 9

Step 11 The peritoneum is closed in the usual manner above and below the rubber tube The muscles, fascia and skin are sutured in tiers above and below the rubber tube Care should be taken to leave just enough space so as not to constrict the rubber tube

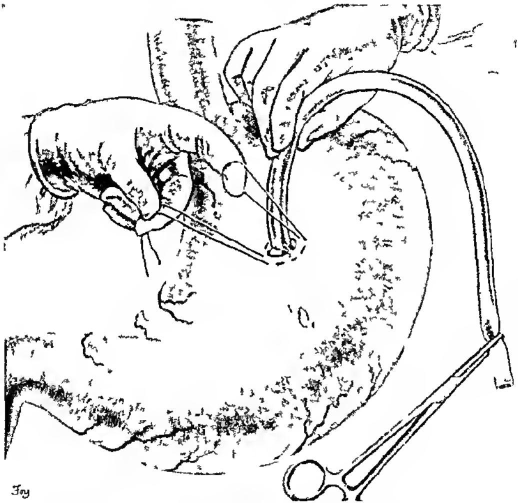

FIG 164 Stamm method of gastrostomy Invagination of the catheter

As may be seen from this description, a canal has been formed out of the anterior wall of the stomach lying in a direction perpendicular to its anterior surface This canal is lined with serous membrane It can be made on a small and contracted stomach, which is the great advantage of the method, since it is well known that in cases of stricture of the esophagus the stomach is usually small and contracted The operation is very simple in its technic, which is also a very important factor, because,

as a rule, patients object to such an operation as gastrostomy and they submit to it only when they are extremely emaciated and dehydrated.

On the other hand, the disadvantage of this method is that the canal is lined with serosa. As is well known, two serous surfaces brought together

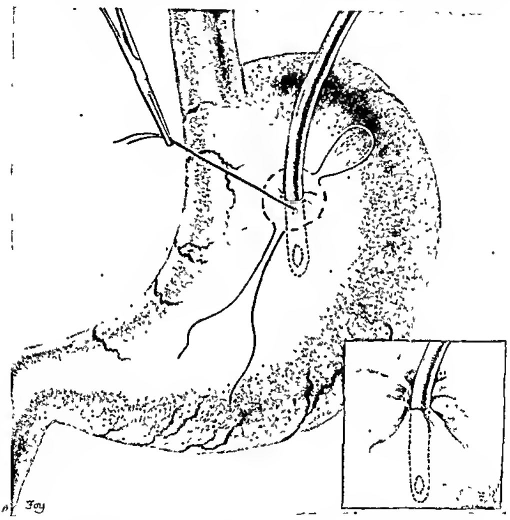

FIG. 165. Stamm method of gastrostomy. Inserting another purse-string suture around the catheter.

and constantly irritated by the periodic introduction of a rubber tube have a tendency to become adherent to each other, *i.e.*, there is a tendency for the canal to become obliterated, with the result that after a few weeks or months it becomes progressively more difficult to introduce a rubber tube to feed the patient.

Notwithstanding this disadvantage, this method is most commonly used in the United States. It has been erroneously attributed to Emanuel

Senn, and is often called "Senn's method" However, this method was described by Stamm, Professor of Surgery in Wooster University, Cleveland, Ohio, and was published in 1894 Senn described a different method, which was published later in 1896

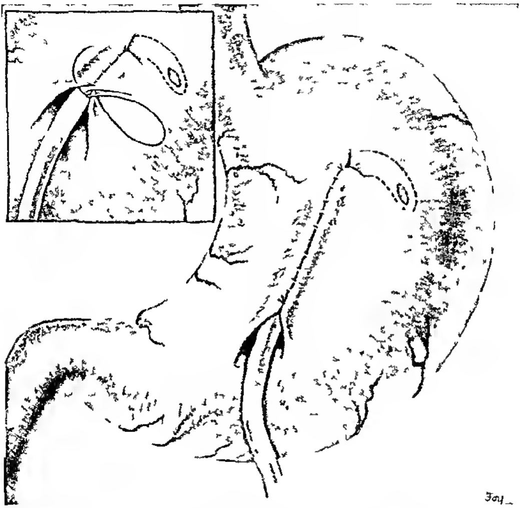

FIG 166 Witzel method of gastrostomy (Gernez modification)

THE WITZEL METHOD (GERNEZ MODIFICATION)

Witzel method was suggested in 1891, and is characterized by the formation of a channel from the anterior stomach-wall which is lined with serosa In Witzel's method the opening into the stomach is situated at the lower end of a channel, Gernez modified it by placing the opening at the upper end

Step 1 The same as Step 1 in the Stamm method with the difference only that the incision is made on the fundus

Steps 2 to 6 are precisely the same as in the Stamm operation.

Step 7. The rubber tube is laid on the anterior wall of the stomach in a direction away from the cardia. A series of seromuscular interrupted or continuous sutures is made on each side of the tube. The distance of each bite from the tube should be about half an inch. The length of the channel thus formed will be three inches (Fig. 166).

Step 8. The stomach is fastened to the anterior abdominal wall at two points, one proximal to the proximal end and the other distal to the distal end of the tube. The method of fixation of the stomach is precisely the same as described in the method of Stamm under Step 9.

Until Stamm published his method in 1894, Witzel's method was used in nearly all the clinics of Continental Europe. His method has a decided advantage over all the older methods because here a canal is formed, a sort of a very short esophagus. This canal, three inches long, runs parallel to the curvatures of the stomach and is lined with serosa. Although this method has definite merits, it has also some objectionable features, which are common to all the methods in which the canal is lined with serosa, namely that the canal has a tendency to become obliterated, making it increasingly difficult to introduce the rubber tube and feed the patient.

In order to overcome this difficulty, G. Marwedel offered his method:

THE MARWEDEL METHOD (FIG. 167, c)

This method was suggested in 1896.

Technic.

Step 1. A seromuscular incision is made on the anterior stomach-wall three inches in length and situated midway between the greater and lesser curvatures.

Step 2. The mucosa is caught at the upper angle of the incision by an Allis forceps and pulled tightly so that it forms a cone.

Step 3. The mucosa is cut with scissors just below the Allis forceps.

Step 4. A rubber tube is inserted into the lumen of the stomach for a distance of one and one-half inches and is fastened at the opening of the mucosa. The adjoining portion of the rubber tube lies on the outer surface of the mucosa (Fig. 167, c).

Step 5. The seromuscular lips of the stomach are sutured to each other over the rubber tube (Fig. 167, c).

Step 6. The stomach is fastened to the anterior abdominal wall at two places. This should be done precisely as described in Steps 9 and 10 of the Stamm method.

Although the Marwedel method has some advantages as compared with the Witzel method, inasmuch as it can be performed on a smaller stomach, nevertheless, in order to place a rubber tube in the canal it is necessary to

separate the seromuscular layer from the mucosa for a considerable width. Another disadvantage is that the rubber tube being introduced into the channel from time to time is liable to tear the posterior wall of the channel which consists only of mucosa. In all, we may say that this method has no advantages over the Witzel method and very few surgeons use it.

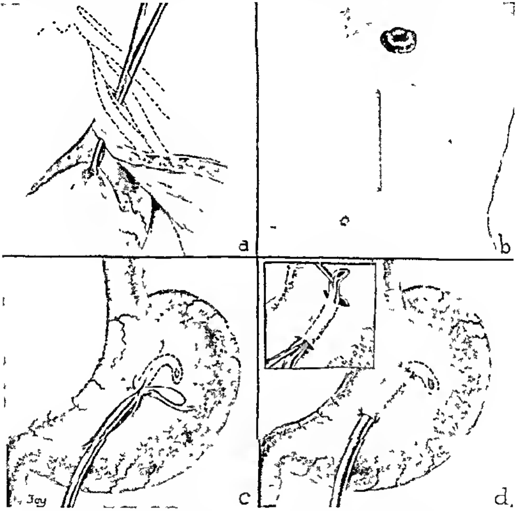

FIG 167 Types of gastrostomy a and b Hahn method, c Marwedel method, d Schnitzler method

THE SCHNITZLER METHOD

Another modification of the Witzel method was described by Schnitzler in 1896. This operation is of interest in that in addition to its use in gastrostomy, the principle is utulized by other surgeons in certain other operations, such as gastropexy, transplantation of ureters and certain types of cholecystogastrostomy.

Technic.

Step 1. The same as Step 1 in the Stamm method.

Step 2. A second longitudinal incision, half an inch long, is made through the seromuscular layer of the anterior wall of the stomach two inches closer to the cardia than the first incision. The wall of the stomach between these two incisions is undermined by a curved artery-forceps introduced behind the seromuscular layer of the stomach-wall (Fig. 167, d). One end of a rubber tube is caught by the jaws of the artery-forceps protruding from the lower opening of the canal and is drawn through the canal.

Step 3. The lips of the lower incision are sutured to each other at the side of the rubber tube.

Step 4. An opening into the stomach is made by incising the mucosa, which was exposed after the upper seromuscular incision was made, and the protruded end of the tube is inserted into the lumen of the stomach.

Step 5. The seromuscular lips of the upper incision are sutured to each other.

Step 6. The stomach is fastened to the anterior abdominal wall at two points precisely in the same manner as described in the Witzel method.

The final results are the same as in the Marwedel method.

THE KADER METHOD

This method was suggested in 1896. In it the canal is also formed from the anterior stomach-wall, but instead of lying parallel to that wall, as in the Witzel method, it lies perpendicular to it. The canal in this method is also lined by the serosa. The description given below has some technical deviations from the method described by Kader. The final result, however, is precisely the same as in Kader's original description.

Step 1. The stomach is walled off from the rest of the peritoneal cavity by towels. A seromuscular incision, the length of which is half an inch, is made through the anterior wall of the stomach. This incision lies midway between the greater and lesser curvatures.

Step 2. The protruding mucosa is caught by an Allis forceps and pulled upward so that a cone is formed. The mucosa is cut with scissors beneath the forceps.

Step 3. The Allis forceps holding the mucosa is drawn upward. This eliminates the leakage of gastric contents from the opening. The tube of the suction-apparatus is inserted into the lumen of the stomach and the gastric contents, if there are any, are sucked out. A rubber tube, No. 20 of the French scale, with its end held by a Kocher forceps, is inserted into the lumen of the stomach for a distance of one inch. The Allis forceps and the Kocher hemostat are held together with the same hand. By this

maneuver the rubber tube becomes immobilized and will neither slip downward nor move upward, which is important for the next step

Step 4 A round curved intestinal needle penetrates the edge of the mucosa and the adjoining wall of the rubber tube The ends of the thread

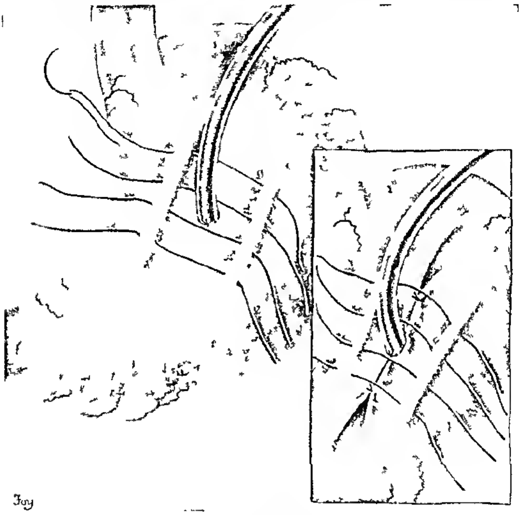

Fig 168 Kader method of gastrostomy

are tied and the Kocher clamp which holds the end of the rubber tube is removed from the lumen of the stomach

Step 5 Two seromuscular seromuscular sutures are placed on each side of the rubber tube The distance between the rubber tube and each adjoining stitch as well as the distance between the first and second seromuscular seromuscular sutures, is about three fourths of an inch The distance between two bites of the same suture is a little more than one inch

(Fig. 168, main picture). The ends of each suture are tied and cut short.

Step 6. Step 5 is repeated, using the same distances (Fig. 168, insert).

As already mentioned, in most of the methods of gastrostomy the surgeon encounters several difficulties. One of them is that the canal is lined with serosa and therefore has a tendency to become obliterated. Another difficulty is that the canal is not watertight.

In order to overcome these difficulties, many surgeons tried to make a canal from the stomach-wall and lined it with mucosa, and in order to make it watertight they placed it in a subcutaneous canal and compressed it from the outside by means of a bandage. To this type belong the method of Ssabanejev and its modifications (Helferich, Jaboulay and Lucy).

THE SSABANEJEV METHOD

This operation was first performed by a Russian surgeon, Ssabanejev, in May, 1890, and was published in "Vratch" in the same year.

Step 1. The abdomen is opened by a left midrectus incision (Fig. 169, insert).

Step 2. A small incision, which is half an inch long and penetrates the skin and the superficial fascia only, is made in the fifth left intercostal space immediately to the left of the sternum (Fig. 169, insert). Then, with a curved forceps, the skin and the superficial fascia are undermined in the direction toward the opening in the abdomen, so that a channel is formed leading into the abdominal cavity (Fig. 169).

Step 3. The anterior wall of the stomach is grasped by an Allis forceps close to the fundus and brought to the tips of the blades of the artery-forceps which protrude from the subcutaneous canal. The stomach is then grasped and drawn through the subcutaneous canal (Fig. 170, a) by the artery-forceps (or by an Allis forceps).

Step 4. The base of the small cone protruding from the upper end of the subcutaneous canal is sutured to the lips of the skin (Fig. 170, a).

Step 5. The abdominal wound is closed (Fig. 170, b).

Step 6. The small cone is opened and its edges are sutured to the skin (Fig. 170, b).

As may be seen a canal is formed which is lined with mucous membrane and therefore has no tendency to become obliterated. However, it is not watertight, and it is necessary to keep continuously a bandage over the subcutaneous canal for its compression, thus rendering the stomach watertight. Another disadvantage of this method is that it requires a large stomach. In case of stricture of the esophagus the stomach is usually small and contracted. The method of Ssabanejev was first reported by Vinokurov in 1890. Rudolph Frank of Vienna, not knowing of the work of Ssabanejev, described it in 1893. However, the priority belongs to Ssabanejev.

Although this operation is not very much used today, we have described it in detail not only because it is used even now by some surgeons but also because in it for the first time was suggested the idea of forming a subcutaneous tunnel for making hollow viscera watertight. This idea has been utilized by some surgeons for certain colostomy operations.

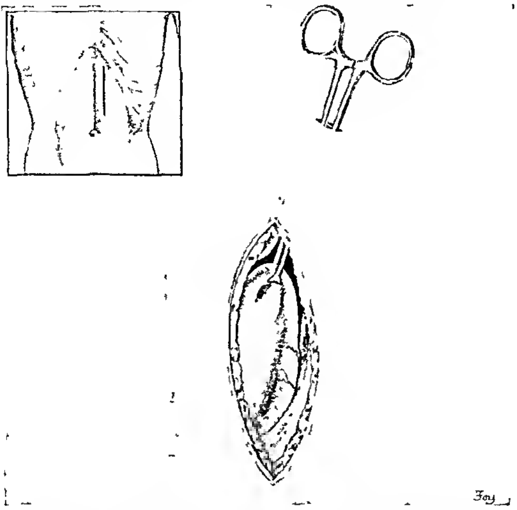

FIG 169 Ssabanejev method of gastrostomy *Insert*—Skin-incision on the abdomen and the chest-wall *Main picture*—Grasping the stomach by an Allis forceps

In order to increase the watertightness of the stomach, Helferich modified Ssabanejev method. All the steps of his operation are the same as in the original Ssabanejev method with the difference only that after Step 3 of the original method is completed, he twists the small cone of the upper wound 180 degrees and then sutures the incised mucosa to the lips of the upper skin-wound.

Jaboulay, in 1894, modified the Ssabanejev method by making the smaller skin-incision just a little to the left of the umbilicus instead of in the fifth intercostal space and connecting the two skin-incisions by a subcutaneous canal (Fig. 171, a). Then the cone of the stomach is more angu-

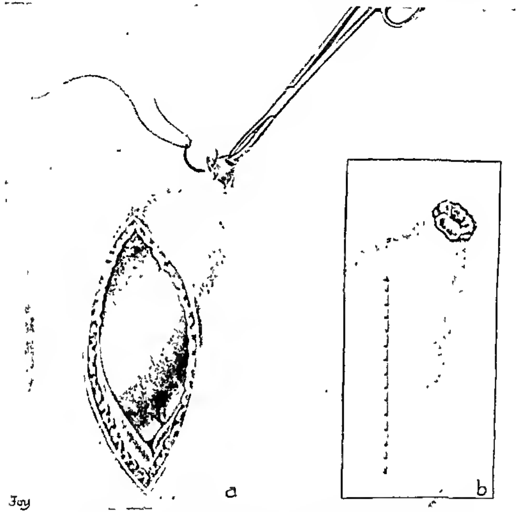

FIG 170 Ssabanejev method of gastrostomy. a. The stomach-cone is drawn through a a subcutaneous canal; b. The cone is opened. Final view.

lated than in the Ssabanejev method and also for this reason more watertight. Moreover, this operation can be performed on a small and contracted stomach.

Lucy, in 1899, instead of making the smaller incision close to the midline made it close to the lateral border of the rectus muscle. His method has the same features as the Jaboulay method (Fig. 171, b).

The method of Ssabanejev and its modifications eliminate one complication, namely, the possibility of obliteration of the canal However, the disadvantages of this method are that the operation cannot always be performed, since it requires a large stomach, and also that the stomach

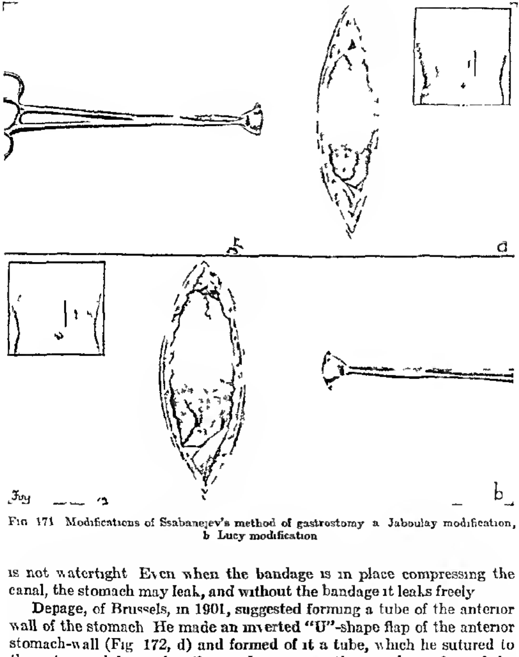

FIG 171 Modifications of Ssabanejev's method of gastrostomy a Jaboulay modification, b Lucy modification

is not watertight Even when the bandage is in place compressing the canal, the stomach may leak, and without the bandage it leaks freely

Depage, of Brussels, in 1901, suggested forming a tube of the anterior wall of the stomach He made an inverted "U"-shape flap of the anterior stomach-wall (Fig 172, d) and formed of it a tube, which he sutured to the anterior abdominal wall in such a manner that on the surface of the

skin only a small pinkish opening was seen leading into the tube. It is easy to feed the patient through such an opening, and it does not become obliterated. However, the great drawback to this method is that the stomach is not watertight; indeed, it leaks more than in many of the previously described methods.

Janeway, in 1913, described a method which actually is identical with the Depage method with the difference only that he made a flap which is reversed to that employed by Depage (Fig. 172, a, b). It has definite advantages over Depage method because in his method the opening leading into the stomach lies in the upper portion of the stomach close to lesser curvature, whereas in Depage method the opening lies close to greater curvature.

Hirsch, in 1911, suggested forming a flap from the anterior gastric wall, the base lying near the cardia and the free end close to the pylorus (Fig. 172, c).

The great drawback to all these flap-methods is that the stomach is not watertight and the gastric contents leak just as much as in the older methods.

THE TAVEL METHOD

In this method, described in 1906, Professor Tavel, of Bern, formed a short esophagus out of a loop of the jejunum. He resected a small portion of the jejunum, three inches long, leaving it hanging on its vascular pedicle, and implanted its anal end into the anterior wall of the stomach. Its oral end he brought outside and attached it to the skin (this short segment of the jejunum he brought to the anterior wall of the stomach by cutting the transverse mesocolon and the gastro-colic ligament). Thus, he believed the escape of gastric contents through the tube would be more difficult because the food would have to go in an antiperistaltic direction. However in this method only one aim was actually accomplished, namely, that the canal did not become obliterated, since it was lined with mucosa. But the gastric contents still escaped whenever intragastric pressure was increased as, for example, when the patient coughed or strained. Another great disadvantage of this operation is that the technic is very complicated and not commensurable to the results obtained. Therefore, the method is not used at all. We mention it not merely because of its historical interest but also to show how dissatisfied the surgeons were with the numerous methods suggested and how persistent they were in the search for better methods.

THE SPIVACK METHOD

In order to eliminate the possibility of leakage, Spivack, in 1929, described a method, the characteristic feature of which is the formation of a valve at the base of the tube. This valve allows the food to be introduced

into the lumen of the stomach, and hermetically closes the stomach whenever the intragastric pressure is increased, thus preventing an escape of the food through the tube Therefore, it makes the stomach watertight

In this operation the tube and the valve are formed from a flap of the anterior wall of the stomach (Fig 172, a, b, c, d)

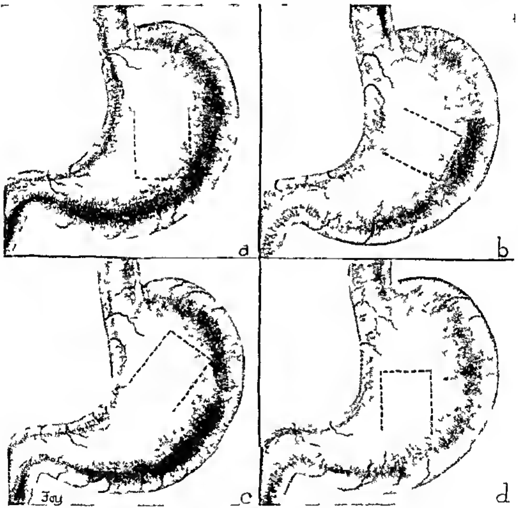

FIG 172 Flaps of the anterior stomach wall a and b Janeway flap c Hirsch flap, d Depage flap

Technic.

Step 1. A quadrangular area is outlined on the anterior wall of the stomach three inches long and two inches wide [if, however, the stomach is not large enough for this, it may be made two and one half inches long and two inches wide] An Allis forceps is placed at each angle of this

quadrangular area (Fig. 173). [It should be emphasized here, that although Spivack made his flap as an inverted U ("Ω") nevertheless, this is not an essential feature of his method. The flap may he made in any direction] (Fig. 172).

Step 2. A seromuscular suture is made between the points A and B

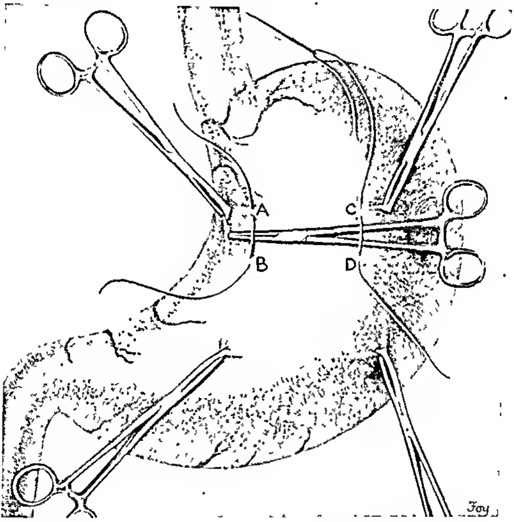

FIG. 173. Spivack tubo-valvular gastrostomy. Doubling the anterior gastric wall

and C and D. The distance between A and B or C and D is from one to one and one-third inches. An artery-forceps is placed behind the threads connecting A with B and C with D. The ends of the thread which connects A with B are tied and clamped. The ends of the thread which connects C with D are also tied, and an artery-forceps is placed on one end of the thread and with the other end of the thread on the needle the next step

is performed (Fig 174) Before starting the next step, the two Allis forceps which have been placed previously at points close to A and C are withdrawn

Step 3 The two ridges thus formed are sutured together by a continuous seromuscular suture (Fig 174, insert) Thus, the upper half of the

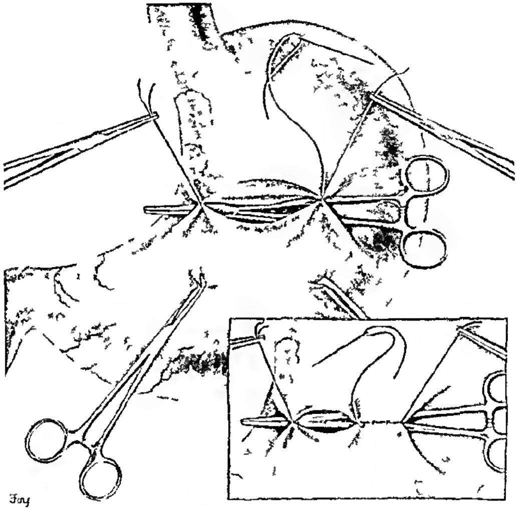

Fig 174 Spivack tubo-valvular gastrostomy Doubling the anterior gastric wall (continuation)

flap is doubled The artery forceps or probe lying behind the bridge is now withdrawn

Step 4 Two seromuscular vertical incisions connecting the points AB and CD with the lower angles of the quadrangular area are made, and also a transverse incision connecting these lower angles with each other

(Fig. 175). [In order to prevent the contraction of the seromuscular layer while making the transverse incision, each lower angle of the flap is caught by an Allis forceps before the transverse incision is made. If large blood-vessels are seen on the mucous membrane they may be ligated before the mucosa is opened. We prefer to ligate only the blood-vessels which lie close

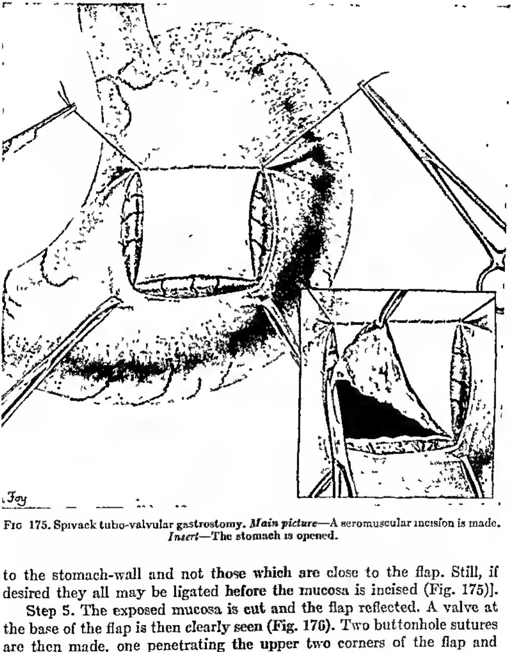

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FIG 175. Spivack tubo-valvular gastrostomy. *Main picture*—A seromuscular incision is made. *Insert*—The stomach is opened.

to the stomach-wall and not those which are close to the flap. Still, if desired they all may be ligated before the mucosa is incised (Fig. 175)].

Step 5. The exposed mucosa is cut and the flap reflected. A valve at the base of the flap is then clearly seen (Fig. 176). Two buttonhole sutures are then made, one penetrating the upper two corners of the flap and the other passing through two points at the base of the flap (Fig. 176).

The ends of both are tied and clamped The lower angle of the stomach incision is grasped by an Allis forceps (Fig 176) The ends of the two previously made sutures which are the beginning and the end of the seromuscular suture which connected the ridges to each other are now cut short

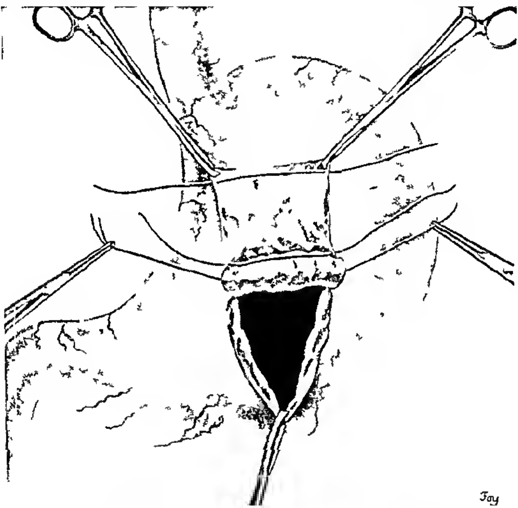

FIG 176 Spivack tubo-valvular gastrostomy The valve is exposed Beginning the construction of a tube

Step 6 An artery forceps is inserted into the stomach through the tube thus formed The opening into the stomach is closed by an over and over suture, as also are the lips of the tube When the first layer is completed it is reinforced by a second seromuscular layer (Figs 177 and 178)

Step 7 The weak spot at the junction of the suture line of the tube with that of the stomach is now reinforced by three interrupted seromuscular sutures (Fig 179 insert)

Step 8. The anterior wall of the stomach is sutured to the parietal peritoneum. A bite is taken through the parietal pertioneum and the posterior sheath of the rectus muscle of one lip, then through the seromuscular layer of the stomach at a point just below and proximal to the base of the tube, and then through the peritoneum and the posterior sheath of the rec-

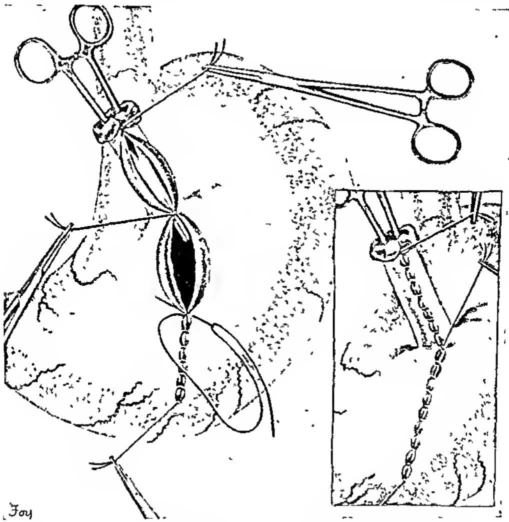

FIG. 177 Spivack tubo-valvular gastrostomy. Suturing the tube and closure of the opening in the stomach.

tus muscle of the other lip, and the ends are tied. The same is done to connect the peritoneum and the transversalis fascia of one lip with the stomach at a point lying above and distal to the base of the tube, and then with the peritoneum and the transversalis fascia of the second lip. Before tying the thread care should be taken to see that the tube is not constricted (Fig. 179). The rest of the peritoneal cavity is then closed in the usual manner.

Step 9 The wall of the tube is then sutured to the muscles and to the anterior sheath in the same manner as described in Step 8 (Fig 180, a)

Step 10 The skin is attached to the tube in four places (Fig 180, b) The sutures penetrate the subcuticular layer of one lip of the skin and then the seromuscular layer of the wall of the tube at a distance about half

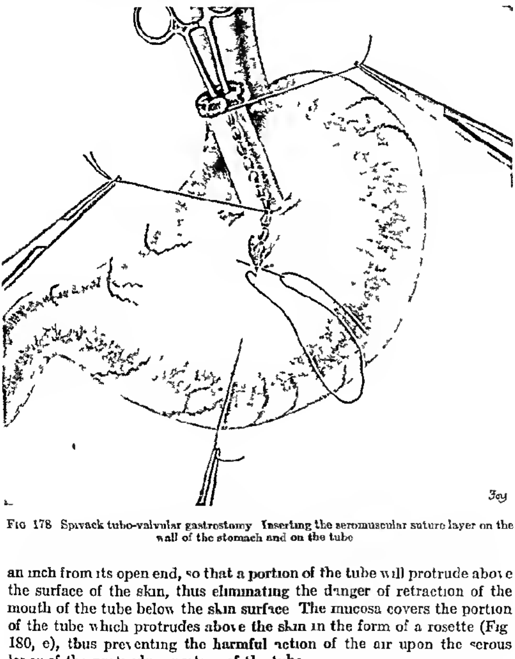

FIG 178 Spivack tubo-valvular gastrostomy Inserting the seromuscular suture layer on the wall of the stomach and on the tube

an inch from its open end, so that a portion of the tube will protrude above the surface of the skin, thus eliminating the danger of retraction of the mouth of the tube below the skin surface The mucosa covers the portion of the tube which protrudes above the skin in the form of a rosette (Fig 180, e), thus preventing the harmful action of the air upon the serous layer of the protruding portion of the tube

A tube is thus formed, which is lined with mucosa and, therefore, the canal will not become obliterated. The valve at the base of the tube assures the watertightness of the stomach.

Before attaching the tube and the stomach to the anterior abdominal wall, the tube may be carried through an opening in the omentum (Fig.

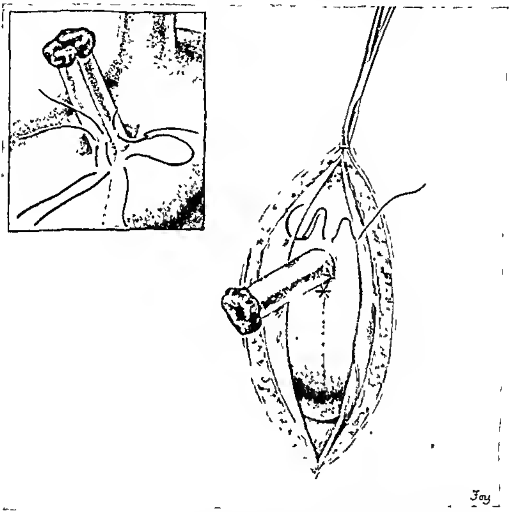

FIG. 179. Spivack tubo-valvular gastrostomy. *Insert*—Making a cuff around the base of the tube. *Main picture*—Suturing the stomach to the parietal peritoneum.

181, main picture). Thus, not only is the junction of the tube and of the stomach reinforced but also the suture-line of the anterior stomach-wall is protected.

Spivack's method can be used also on a small and contracted stomach. However, being confronted with a case of a very small and contracted stomach Spivack modified his usual technic in the following manner:

Step 1. The same as Step 1 in the previous operation (Fig. 173).

Step 2. The same as Step 2 in the previous operation (Fig. 174).

Step 3. The crests of the two ridges are united by a continuous sero-muscular suture. The gastro-colic ligament is cut between the points E and F, and part of the posterior wall of the stomach is drawn out (Fig. 182,

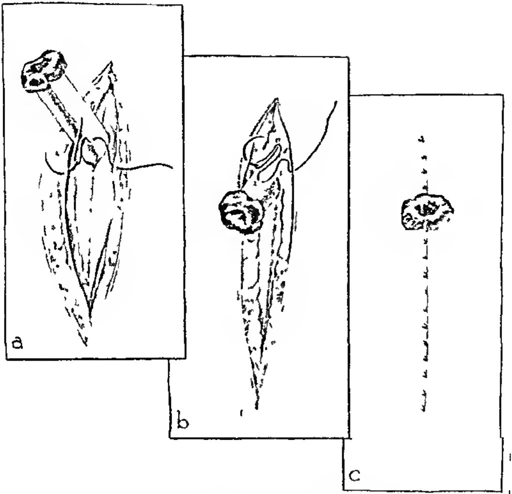

FIG 180 Spivack tubo-valvular gastrostomy a Suturing the anterior sheath to the tube, b Suturing the subcuticular layer to the tube, c Final view

ins.). The gastro-epiploic artery (or arteries) is ligated between two ligatures at E and F (Fig. 182, ins.).

Step 4. The same as Step 4 in the previous operation (Figs. 175 and 182).

Step 5. The same as Step 5 in the previous operation (Figs. 175, 176).

Step 6. The same as Step 6 in the previous operation (Figs. 177, 178).

Step 7. The same as Step 6 in the previous operation (Fig. 179, ins.).

Step 8. The gastro-colic ligament is sutured to the stomach at the places where it was cut in Step 3 (Fig. 182).

Step 9. The same as Step 8 in the previous operation (Fig. 179, main picture).

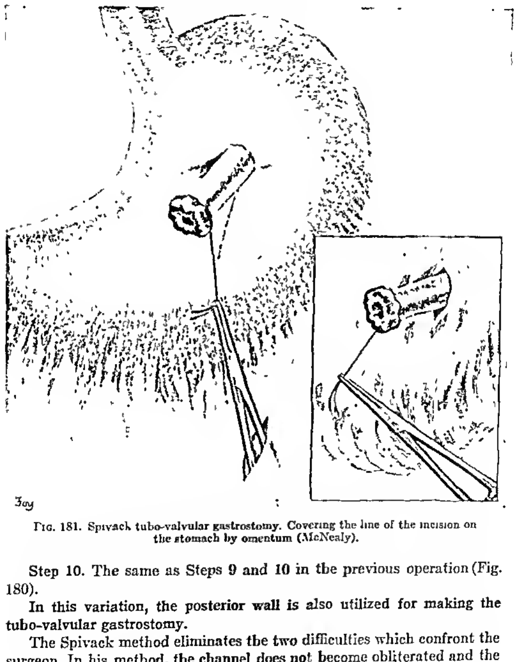

Fig. 181. Spivack tubo-valvular gastrostomy. Covering the line of the incision on the stomach by omentum (McNealy).

Step 10. The same as Steps 9 and 10 in the previous operation (Fig. 180).

In this variation, the posterior wall is also utilized for making the tubo-valvular gastrostomy.

The Spivack method eliminates the two difficulties which confront the surgeon. In his method, the channel does not become obliterated and the

stomach remains watertight We consider this tubo-valvular gastrostomy as the operation of choice.

Of all the methods described we recommend

The Stamm method in case of a temporary gastrostomy for a short duration

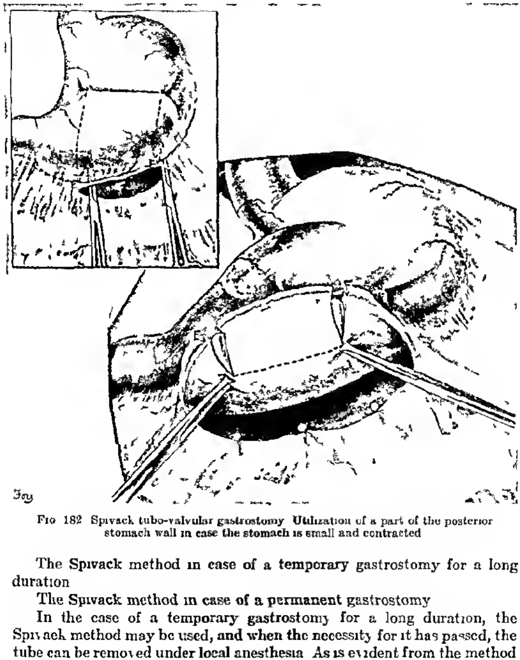

Fig 182 Spivack tubo-valvular gastrostomy Utilization of a part of the posterior stomach wall in case the stomach is small and contracted

The Spivack method in case of a temporary gastrostomy for a long duration

The Spivack method in case of a permanent gastrostomy

In the case of a temporary gastrostomy for a long duration, the Spivack method may be used, and when the necessity for it has passed, the tube can be removed under local anesthesia As is evident from the method

of fixing the tube, it will not be necessary to open the peritoneal cavity, because the tube lies extra-peritoneally.

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CHAPTER XII

PYLOROPLASTY

Definition

The term "Pyloroplasty" consists of two Greek words πυλωρός, pylorus and πλασσειν to form

This operation consists of an enlarging of the pyloric outlet by means of an incision made in one direction which is closed by suturing in the direction perpendicular to the line of incision

This operation was first performed by Heineke and described by Friedrich Fronmuller, of the former's clinic in Erlangen in 1886 The next year, Mikulicz independently and not knowing of the work of Heineke, described it hence the name "Heineke Mikulicz operation "

Indications

The indications for this operation are rather limited It is used in certain cases in which the pyloric outlet becomes narrowed which frequently is due to scar formation in a healed pyloric ulcer This operation was used more extensively at the time when pylorectomy was followed by a great mortality and surgeons preferred to perform a pyloroplasty than to jeopardize the life of the patient by performing a pylorectomy Many surgeons preferred this operation to gastro-jejunostomy, since in the latter operation, the normal physiological arrangement of the gastro intestinal tract is disturbed, that is the duodenum is transformed into an excretory duct conveying bile and pancreatic juice whereas in the case of pyloroplasty the physiological conditions remain unaltered

Surgeons who have had considerable experience with this operation are dissatisfied with the results obtained Mayo has found that extensive adhesions commonly follow the operation and that the pyloric opening becomes fixed at a high level Under such circumstances it is often difficult for the food to pass through the highly situated pyloric outlet

This operation is now advocated only for cases of pylorospasm in which there is not an extensive formation of scar tissue and in which the acidity of the stomach is high However, in cases in which there is an organic stricture of the pylorus and only a moderate degree of acidity is present, gastro-enterostomy is preferable

HEINEKE MIKULICZ OPERATION (FIG 183)

Technic

Step 1 Abdominal incision, either longitudinal or transverse

Step 2 A transverse incision is made through the pylorus and the

adjoining part of the duodenum the length of which should be approximately one inch longer than the length of the stricture, and which should extend beyond the stricture both on the gastric and the duodenal sides (Fig. 183, insert). This incision cuts through the entire thickness of the anterior pyloric wall.

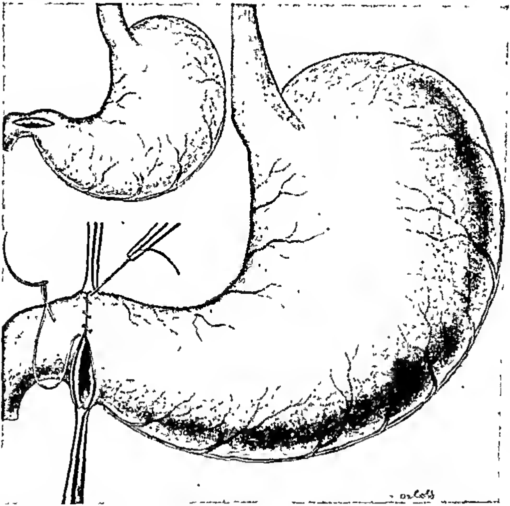

FIG. 183. Heineke-Mikulicz pyloroplasty. *Insert*—A transverse incision is made. *Main picture*—A transverse slit is transformed into a longitudinal one.

Step 3. The middle points of both the upper and lower lips are caught by Allis forceps. The upper lip is drawn upward and the lower lip downward (Fig. 183, main picture).

Step 4. The opening is closed by two layers of sutures. The first includes the entire thickness of the wall and the second, the seromuscular layer, reinforces the first.

C H MAYO MODIFICATION OF THE HEINEKE-MIKULICZ PYLOROPLASTY

The incision in this operation is horse shoe in shape It is longer than the incision in the Heineke-Mikulicz operation and not as long as in the Finney gastro-duodenostomy The line of the "flap incision" is not so close to the greater curvature or to the pyloric angle as in the case of the Finney gastro duodenostomy, and this makes it possible to remove a pyloric or duodenal ulcer if present The closure is the same as in the Heineke Mikulicz operation

HORSLEY MODIFICATION OF THE HEINEKE MIKULICZ OPERATION (FIG 184 LOWER HALF)

This method of pyloroplasty, according to its originator, is suitable only in cases in which there is a small ulcer in the first part of the duodenum, or a small prepyloric ulcer, and also when it is desired to give rest to the stomach after excision of a small ulcer in other regions of that organ The ulcer is removed as a routine procedure If the ulcer is of a large size, or if it is farther away than one inch on the duodenal side or two inches on the stomach side of the gastro-duodenal junction, then pyloroplasty is not a suitable procedure and the surgeon should resort either to a gastro-enterostomy or to a pylorectomy

Technic

Step 1 An incision one inch long is made on the duodenum and two inches long on the pylorus [N B As a rule, the gastric side of the incision should be twice the size of the duodenal]

Step 2 A suture connecting the gastric end of the incision with the duodenal end is made, which penetrates, in the stomach the seromuscular layer only, and, in the duodenum the entire thickness of its wall (Fig 184, lower half) The ends of this thread are tied to each other This transforms the transverse into a longitudinal incision Another suture connecting the seromuscular layer of the stomach with the entire thickness of the duodenal wall is made half an inch above the first one and its ends are also tied The rest of the opening is sutured by grasping only the seromuscular layer of the stomach and the entire thickness of the wall of the duodenum

Step 3 This suture line is reinforced by a second row of seromuscular sutures, beginning and ending with a purse string suture

Step 4 The suture line is covered by the great omentum, or by the gastro hepatic omentum, to which it is attached by a few sutures

RICHARDSON MODIFICATION OF THE HEINEKE-MIKULICZ PYLOROPLASTY

Step 1 A transverse incision of the Heineke Mikulicz type is made

The upper and the lower lips are trimmed off so that the opening acquires the shape of a lozenge (Fig 184, upper half). Thus, all the cicatricial tissues are cut away.

Step 2. The opening is closed in two layers in the same manner as described in the original Heineke-Mikulicz method.

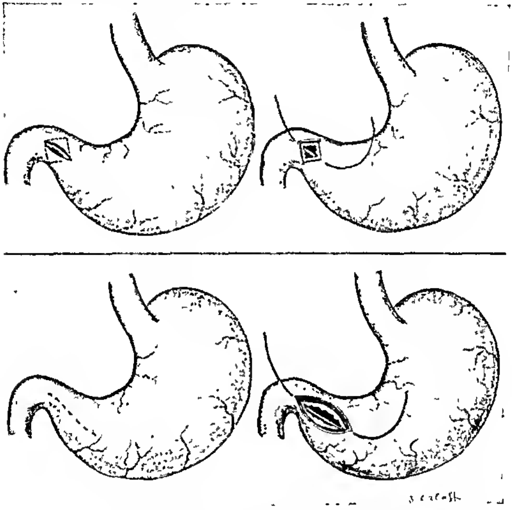

Fig 184 Pyloroplasty. *Upper half*—Richardson modification of the Heineke-Mikulicz operation *Lower half*—Horsley modification of the Heineke-Mikulicz operation.

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CHAPTER XIII

OPERATIONS FOR CONGENITAL PYLORIC STENOSIS

Historical.

The term "Congenital Pyloric Stenosis" was coined rather recently, namely, in 1879, by Landerer. However, the disease has been known probably since 1627. In that year, Fabricius Hildanus (1560–1634) described a condition in an infant which clinically bears a close resemblance to the picture of congenital pyloric stenosis. The infant recovered, and for this reason there is no way of establishing definitely whether or not he actually dealt with a true case of a congenital pyloric stenosis.

The next case was reported by Patrick Blair, in 1717. He recorded the case of a male infant, who "being a month old was seized with a violent vomiting and a stoppage of urine and stool. Some time after both these became more regular, but the vomiting still continued." The infant died when five months old, and the autopsy showed: "The ventriculus was more like to an intestine than a stomach, its length being five inches and its breadth but one inch. The pylorus and almost all of the duodenum were cartilaginous and something inclined to ossification."

Weber, in 1758, recorded the case of a new-born female infant, who "sucked milk without difficulty but soon after she had filled her stomach with this infant nourishment, she returned it by vomiting." She died on the sixth day. The autopsy showed that, "The pylorus was hard to touch like cartilage, and contracted. On incision its substance was seen to be thick, and the tightness of its contraction made the lumen similar."

The next case was reported by George Armstrong, of London, in 1771: It was a description of an autopsy made on an infant who was affected with "watery gripes."

It was found on autopsy that "there was no morbid appearance to be observed anywhere but in the stomach, and this viscus being so full while the intestines were almost empty, looked as if the disease had been chiefly due to a spasm of the pylorus which prevented the contents of the stomach from passing into the duodenum."

Even more clearly the same disease was described by Hezekiah Beardsley, of New Haven, Connecticut, in 1788. On autopsy it was found that "the pylorus was invested with a hard compact substance or scirrhosity which so completely obstructed the passage into the duodenum as to admit with the greatest difficulty the finest fluid; whether this was the original disorder or only a consequence may perhaps be a question."

The first case recorded in Germany was in 1842 by Siemon-Dawosky. He was the first man to mention the projectile type of vomiting.

The name, "Congenital Pyloric Stenosis," as mentioned already, was coined by Landerer, in 1879.

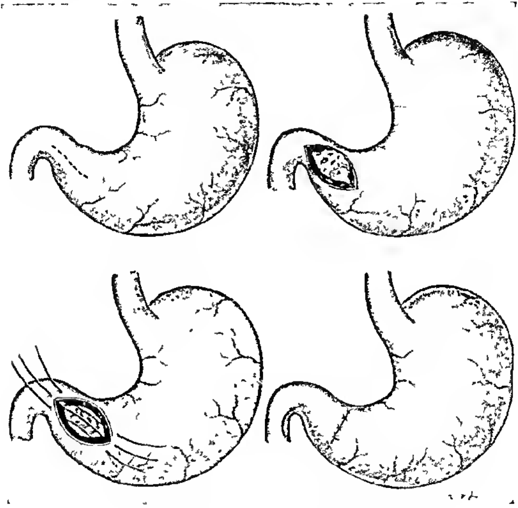

Fig 185 Congenital pyloric stenosis Fredet-Weber operation

Indications.

Cases of congenital pyloric stenosis come to the surgeon as a rule only after medical treatment has failed, although it is true that there are many cases presenting clinical symptoms of congenital pyloric stenosis which respond to medical treatment. For this reason the majority of surgeons believe that each child should be first given medical treatment, and if this fails, that is, if the child after being under the physician's care still continues to lose weight, then only should one resort to surgery. However,

under prolonged medical treatment a good surgical risk may become a bad one.

The preoperative management in these cases is of the greatest importance. This, combined with the proper postoperative care, has reduced the mortality of from twenty-eight or thirty per cent of twenty years ago, to from two to three per cent, which is now the mortality-rate in the hands of the competent surgeon. Some surgeons have reported one hundred consecutive cases without a single death.

The preoperative care consists in giving the infant hypodermoclysis of 200 to 300 c.cm. of normal salt-solution, or of three per cent glucose in normal salt-solution, twice daily, for two days before the operation, and of one blood transfusion (100–150–200 c.cm.) immediately preceding the operation. It may also be useful to give another blood transfusion the day following the operation.

Technic.

The old methods of surgical treatment of this condition was jejunostomy, pylorodiosis, gastro-enterostomy and the Heineke-Mikulicz pyloroplasty. The mortality-rate of these operations was so high that it made them prohibitive. In the case of the Heineke-Mikulicz operation technical difficulties also were added, because it is very difficult to suture in a perpendicular direction the incised thick pyloric ring.

Fredet, in 1907, and Weber, in 1910, suggested an extra-mucous pyloroplasty of the Heineke-Mikulicz type. They cut the pylorus longitudinally through the serosa and muscularis only, and sutured it again in a direction perpendicular to the line of the incision (Fig. 185).

The Fredet-Weber method is very seldom used now. Its interest however is not only historical. It served as a transient step in the development of the operation which is used now not only as an operation of choice but actually as a routine procedure for congenital pyloric stenosis, namely, the Ramstedt operation.

THE RAMSTEDT OPERATION

This was performed by Ramstedt for the first time on June 18th, 1912.

Step 1. The abdomen is opened by a right paramedian incision one or one and one-half inches long. The lower end of this incision is at the level of the umbilicus.

Step 2. A McFadden forceps (Fig. 186, a) grasps the pylorus and delivers it through the abdominal opening. This forceps is then disengaged and the pyloric tumor is held between the index-finger and the thumb of the left hand (Fig. 186, b).

Step 3. An incision parallel to the pyloric canal is made in the "bloodless area," which is usually situated in the upper third of the anterior wall of the pylorus. The serosa and only the superficial layer of the muscularis

are cut along the entire length of the pyloric ring The length of such an incision is on the average about one and one half inches [Care should be taken not to make the incision shorter than is necessary, since then the constriction is not relieved Neither should it be made longer than necessary, particularly on the duodenal end, in order to avoid opening the duo

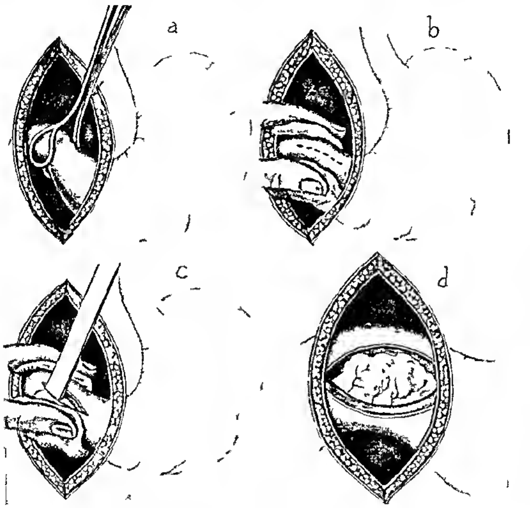

Fig 186 Congenital pyloric stenosis Ramstedt operation

denum] After the superficial layer of the muscle is incised, the separation of the muscle fibers is continued by the handle of the knife (Fig 186, c) until the submucosa is reached This is done with comparative ease, since the muscle is rather friable Then the submucous layer is separated and the mucosa is thus exposed, which immediately bulges through the gap in the muscle (Fig 186, d) The bleeding points are checked by applying hot sponges If this fails, they are sutured, using an intestinal curve

needle [it is not advisable to apply hemostatic forceps to stop the bleeding, since the tissue is very fragile]. Usually the bleeding will be checked by one of the above mentioned manipulations. However, if it is not, then a small piece of rectus muscle may be incised and sutured over the bleeding area.

Step 4. The abdominal wall is closed in layers.

The sutures for all layers should be of silk, since in emaciated children healing is delayed and if an absorbable suture is used, it may dissolve before healing takes place.

This operation is very simple and requires about 10 to 15 minutes for its performance. It would seem to be a hazardous procedure to leave the mucosa exposed and protruding through the thick seromuscular gap. However, no bad sequelæ have resulted from this. A few weeks after the operation, at the place of the former gap only a small scar can be seen, and a few months after the operation it is difficult to find even the scar at the site of the incision.

The results of the operation are excellent. The infants gain weight and are perfectly normal.

Very few modifications of the Ramstedt operation have been described, a certain sign that the operation in itself is excellent and hardly needs any improvement.

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CHAPTER XIV

GASTROPLICATION

Definition.

This term is derived from the Greek γαστήρ, stomach, and the Latin plicare, to fold. It consists in plaiting (or plicating) either the anterior wall of the stomach alone or the posterior stomach-wall as well.

Indications.

The indications for this operation are not very often met with now. It is used occasionally in cases of atonic dilatation of the stomach not due to obstruction of the pylorus. It is occasionally also used for gastroptosis in connection with some other operation, such as gastro-enterostomy or gastropexy. The first who performed this operation was Heinrich Bircher, of Aarau, Switzerland, in 1890, who published an account of it in 1891.

THE BIRCHER METHOD

Step 1. The abdomen is opened in the epigastric region.

Step 2. The stomach is drawn out from the abdominal cavity and its anterior wall exposed. A seromuscular suture connects two points close to the pyloric end of the stomach, and another seromuscular suture two points close to the cardiac end of the stomach. The ends of the same thread are tied to each other.

Step 3. A probe is placed behind the two points tied together, so that a furrow with two ridges is formed on the anterior wall of the stomach.

Step 4. The crests of these parallel ridges are sutured to each other by a continuous seromuscular suture. Thus, part of the anterior wall of the stomach is actually doubled.

The disadvantage of this method is that it diminishes only the size of the anterior wall of the stomach, leaving the size of the posterior wall unaltered. Another disadvantage is that by doubling the anterior wall there is formed a very large fold of this wall which protrudes into the lumen of the stomach and forms there a large partition.

In order to eliminate the formation of this large partition in the lumen of the stomach, Weir modified the Bircher method in the following manner:

THE WEIR GASTROPLICATION METHOD

Step 1. A furrow one inch deep is made on the anterior stomach-wall by pressing a probe upon it. The length of this furrow depends on the length of the stomach in its transverse direction. Eight or ten interrupted seromuscular sutures are taken, thus transforming the furrow into a canal.

Step 2 The probe is then removed and another furrow and canal are made at a distance of one inch below the first one using the same technic as described in Step 1 (Fig 187 main picture) This procedure is repeated until the distance between the greater and the lesser curvatures is reduced to four or five inches

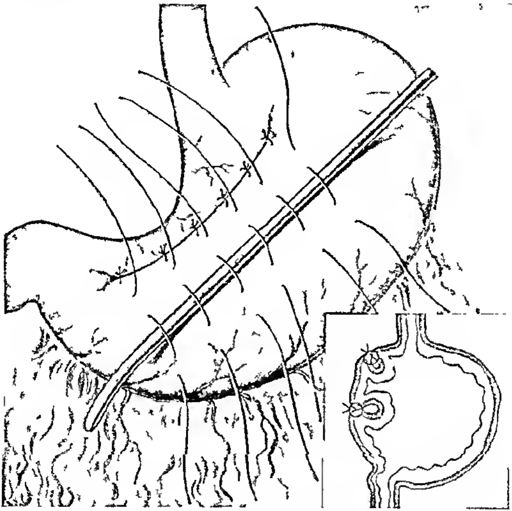

Fig 187 Gastroplication Weir method

The result is the same as in the case of the Bircher method with the difference only that the dead spaces on the serous surface are obliterated and the partition in the lumen is eliminated

In order to overcome the formation of a pouch of the posterior gastric wall Moynihan supplements the gastroplication with a gastro enterostomy

THE MOYNIHAN METHOD OF GASTROPLICATION

Step 1 A series of interrupted seromuscular sutures are taken in the

direction from the lesser to the greater curvature of the stomach. Each thread makes three to four bites and the distance between each successive bite is about one inch (Fig. 188, main picture). Each thread lies at a distance of an inch and a half from the next one. The ends are tied and cut short.

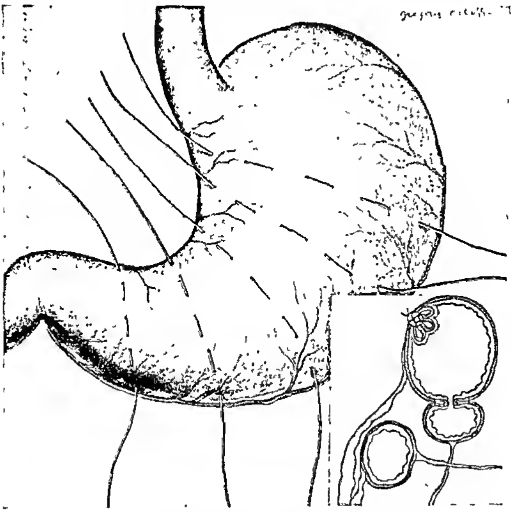

FIG. 188. Gastroplication. Moynihan method.

Step 2. A posterior gastro-enterostomy is performed (for technic of gastro-enterostomy, see Chapter XVI). This is a very important point of the operation, since in Step 1 only the anterior wall of the stomach is plaited and the posterior wall of the stomach forms a deep pouch.

THE BRANDT METHOD OF GASTROPLICATION

To avoid leaving a large pouch formed by the posterior stomach-wall, Brandt in 1894, suggested plicating also the posterior stomach-wall

in a manner similar to Bircher's plication of the anterior wall. The main difficulty comes in exposing the posterior wall. Brandt did this by making small holes in the gastro-colic ligament and drawing out parts of the posterior stomach-wall and pleating them. However, this method is complicated and not as effective as the Moynihan method. We will conclude this chapter by stating again that **gastroplication is now very seldom used.**

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CHAPTER XV

GASTROPEXY

Definition.

The word gastropexy consists of two Greek words: γαστήρ, stomach and πηγνύναι, to attach.

It signifies "The fixation of the stomach."

Indications.

The operation is done for gastroptosis, a downward displacement of the stomach. This disease is not a rarity. It is usually met with in women; 95.4 per cent of all cases of gastroptosis occur in women and only 4.6 per cent in men (Rovsing).

As gastroptosis is often associated with gastrectasia, some surgeons prefer to resort to gastroplication only for its correction, while others employ gastrofixation, and some both gastroplication and gastrofixation combined. While some are using gastroplication with a posterior gastro-enterostomy, others are using a gastropexy with a posterior gastro-enterostomy, and still others are using a gastropexy with a posterior gastro-enterostomy supplemented by an occlusion of the pylorus. As quite frequently gastroptosis is only a feature of gastrocoloptosis, many believe that not only the stomach but also the colon should be fixed. And finally, there are many not only among the internists but also among the surgeons, who consider that gastroptosis is a constitutional disease and that it should be treated medically only.

All the methods of fixation of the stomach can be subdivided into three groups:

A. Operations in which the stomach, or the ligaments connected with it, are sutured directly to the anterior abdominal wall.

B. Operations in which the stomach is fastened in its normal position through some operative procedure on its ligaments without being attached to the anterior abdominal wall.

C. Operations in which not only the stomach but also the colon is attached either to the anterior or to the posterior abdominal wall.

A. OPERATIONS IN WHICH THE STOMACH, OR THE LIGAMENTS CONNECTED WITH IT, ARE SUTURED DIRECTLY TO THE ANTERIOR ABDOMINAL WALL

1. THE DURET METHOD (FIG. 189)

This is the earliest operative procedure of gastropexy and was performed first by Duret, of Lille, France, in 1896.

Step 1. A midline incision is made from the ensiform process down to the umbilicus, incising all the structures down to but not including the peritoneum.

Step 2. The peritoneum is opened only in the lower half of this incision.

Step 3. The stomach is lifted up. A thread attached to a round curved

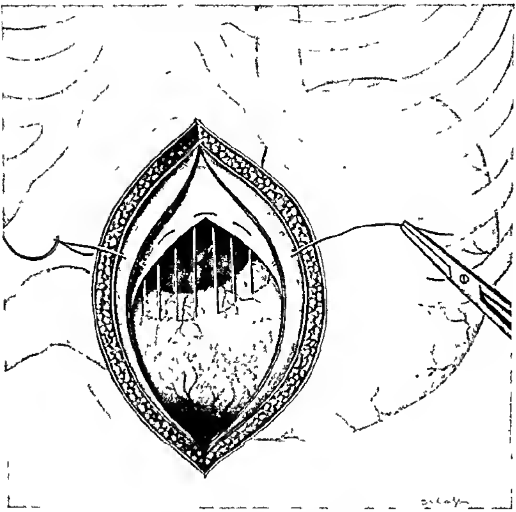

FIG 189 Gastropexy Duret method.

needle passes through the entire thickness of the left lip of the opened abdomen, except the skin. Then, with the same needle, a bite is taken through the seromuscular layer of the stomach close to the cardiac end of the lesser curvature. This is then carried through the undivided portion of the peritoneum from within outward, and then again penetrates the peritoneum from without inward Another seromuscular bite is then taken through the anterior stomach-wall a little away from the previous sero-

muscular bite in the direction toward the pylorus. These movements of catching alternately the peritoneum and the seromuscular layer of the stomach close to the lesser curvature are continued until the antrum is reached. Then the needle pierces the entire thickness of the right lip of the abdomen, with the exception of the skin. The ends of the thread are

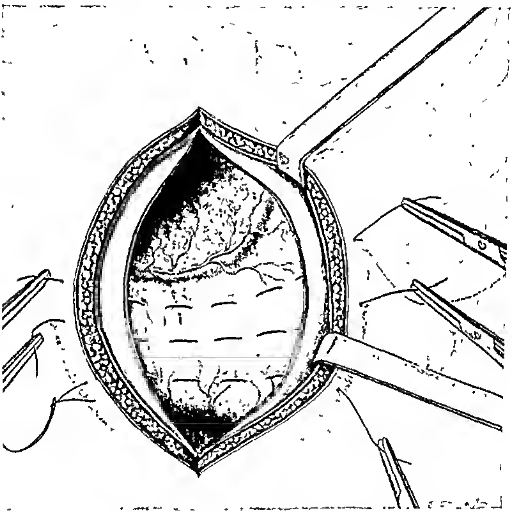

FIG. 190. Gastropexy. Rovsing method.

tied together and cut short only after the anterior sheath is closed. By this maneuvre, the stomach is lifted and fixed to the abdominal wall.

Step 4. The abdomen is closed in layers.

2. THE ROVSING METHOD

This was described in 1899.

Step 1. The abdomen is opened through a midline incision extending from the ensiform process down to the umbilicus.

Step 2 A bite is taken through the entire thickness of the left lip of the abdominal wall from without inward, and then two or three bites are taken through the seromuscular layer of the stomach, and then again through the entire thickness of the right lip of the abdominal wall from within outward A second and a third row of sutures are made in a similar

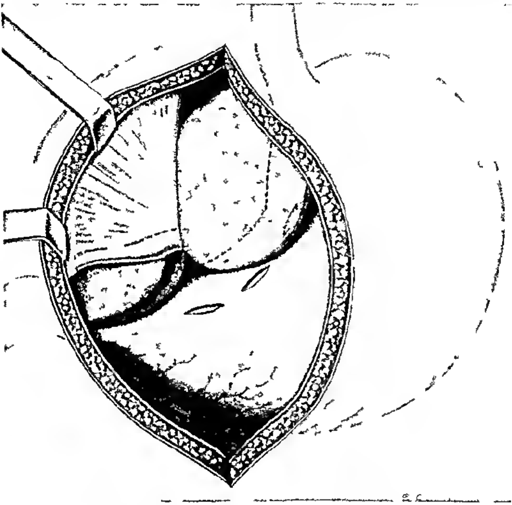

FIG 191 Gastropexy (Perthes method) Separating the round ligament from the falciform ligament

manner, each row being one inch below the previous one (Fig 190) The ends are still not tied

Step 3 The abdomen is closed in the usual way in layers

Step 4 A piece of gauze is placed over the sutured abdominal wall, and the three threads which fastened the stomach to the anterior abdominal wall are tied over it and the ends are cut short The gastrofixation sutures are removed four weeks later

This method is considered by many as one of the best. However, its disadvantage is the same as in the method of Duret, in that extensive adhesions are formed between the stomach and the anterior abdominal wall, which decrease the mobility of the stomach and in many cases produce distress.

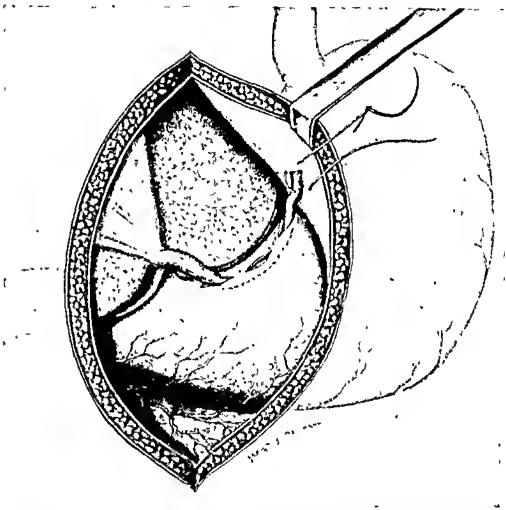

FIG 192 Gastropexy (Perthes method). The round ligament is carried through a seromuscular canal in the stomach-wall and sutured to the posterior sheath of the left rectus muscle.

3. THE PERTHES METHOD

In this method the round ligament of the liver is utilized for lifting and fixation of the stomach.

Step 1. The abdomen is opened through a midline incision.

Step 2. The round ligament of the liver is severed very close to its attachment to the umbilicus, and is separated from its attachment to the falciform ligament along its entire length up to the liver (Fig. 191).

Step 3 The upper free end of the round ligament is transfixed by a silk thread, which is inserted into the eye of a grooved director A seromuscular incision one-quarter of an inch long is made through the anterior stomach wall just proximal to the pylorus Another seromuscular incision of the same length is made at a distance of one to one and one-half inches more proximally (Fig 192) The seromuscular layer between these two incisions is undermined, and with the aid of the grooved director the silk thread with the round ligament are carried through the seromuscular canal thus formed (Fig 192) A third seromuscular incision is made at a distance of one and a half inches still closer to the cardia, and the seromuscular layer is again undermined between the last two incisions and the round ligament is carried through it These manipulations are repeated several times until the round ligament lies close to the cardia

Step 4 The seromuscular lips are sutured over the exposed parts of the round ligament

Step 5 The free end of the round ligament is fastened either to the posterior sheath of the left rectus muscle, or to the cartilage of the seventh left rib at a point located two inches to the left from the ensiform process (Fig 192)

Step 6 The abdomen is closed in the usual manner

As may be seen from this description, Perthes fastens the round ligament of the liver to the anterior wall of the stomach precisely in the same manner as Schnitzler fastens the rubber tube to the anterior stomach-wall in his method of gastrostomy

4 THE VOGEL METHOD

Step 1 The abdomen is opened

Step 2 The round ligament of the liver is cut very close to its attachment to the umbilicus, and is separated from the falciform ligament along its entire length up to the liver

Step 3 The round ligament is laid upon the anterior wall of the stomach midway between the greater and the lesser curvatures and parallel to them (Fig 193, insert)

Step 4 A series of seromuscular bites are taken on each side of the round ligament The distance of each bite from the round ligament is about one-third of an inch, and the distance between each two adjoining sutures is one-half of an inch Six interrupted seromuscular sutures are made in this manner Thus, three inches of the round ligament are buried in the anterior stomach wall (Fig 193)

Step 5 The free end of the round ligament is brought through the peritoneum, the posterior sheath of the left rectus muscle, the left rectus muscle, and the anterior sheath of this muscle to which it is fastened (Fig 193)

Step 6 The abdomen is closed in tiers

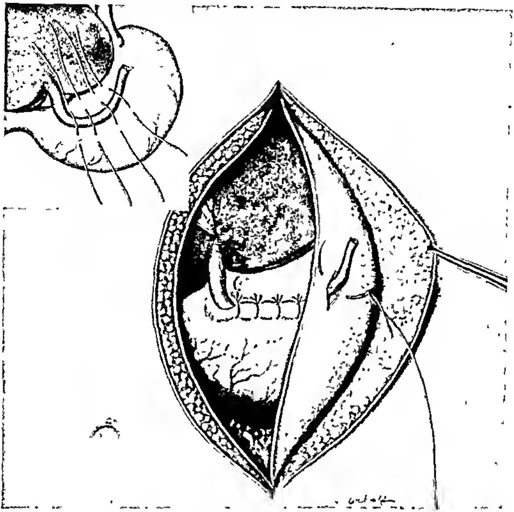

FIG. 193. Gastropexy. Vogel method.

5. THE GÖBBEL METHOD

This was described in 1913.

Step 1. The abdomen is opened.

Step 2. A posterior gastro-enterostomy is performed.

Step 3. A strip from the anterior sheath of the left rectus muscle, 12 cm. by 2 cm., is made and detached from the sheath.

Step 4. A seromuscular flap having its base toward the pylorus, is made out of that portion of the anterior stomach-wall which is adjacent to the pylorus (Fig. 194).

Step 5. The pyloric ring is encircled by a portion of the detached aponeurotic strip, and the ends forming the ring around the pylorus are sutured together with silk sutures (Fig. 194).

Step 6 The rest of the aponeurotic strip is laid upon the muscular surface of the seromuscular flap, and the edges of this flap are sutured to each other so as to surround the aponeurotic strip (Fig 194, insert)

Step 7 The gap in the anterior stomach wall, produced by making the

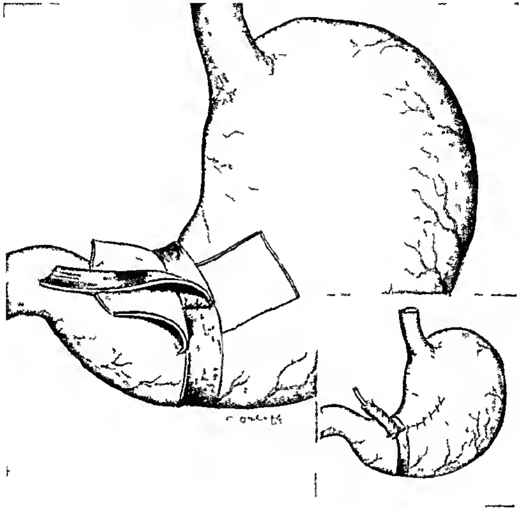

Fig 194 Gastropexy Göbbel method

seromuscular flap, is closed by a series of interrupted or continuous seromuscular sutures (Fig 191, insert)

Step 8 The newly formed suspensory ligament is brought outside the abdominal cavity by piercing the peritoneum, the posterior sheath of the left rectus muscle, this muscle itself, and its anterior sheath to which it is fastened

Step 9 The abdomen is closed in tiers

6. THE ABRASHANOW METHOD

This was described in 1925. The characteristic feature of this method is that three suspensory ligaments are constructed either from the anterior sheath of the rectus muscle or from the fascia lata, two of which are then attached to the anterior wall of the stomach [one close to the pyloric and the other to the cardiac end of the lesser curvature], and the third to the posterior wall of the stomach close to the mid-point of the lesser curvature.

Step 1. The abdomen is opened by a midline incision.

Step 2. Three strips are cut from the anterior sheath of the rectus muscle or from the fascia lata. The size of the strips is 4 to 5 cm. by 1½ cm.

Step 3. Three small seromuscular incisions are made close to the lesser curvature. One is made two fingers' width to the left from the antrum on the anterior wall of the stomach, another, at the middle point of the lesser curvature, but only on the posterior wall, and the third, below the cardia on the anterior wall of the stomach. A seromuscular canal is undermined in an upward direction for a length of 2 cm., starting from each of the seromuscular openings. Three seromuscular channels are thus formed. Each strip is carried through the seromuscular channel for half of its length, so that a portion of the strip projects from each end of the channel. Each of the small seromuscular incisions is then closed. The two ends of each strip are brought outside the abdominal cavity through the upper angle of the wound, piercing the peritoneum, muscle and the anterior sheath of the rectus muscle, and each end of the strip is sutured to the other end of the same strip and also to the anterior sheath of the rectus muscle.

7. THE LAMBRET METHOD

This was described in 1929, by O. Lambret, of Lille, France, who makes an aponeurotic flap of the anterior sheath of the left rectus muscle, the size of which is 12 cm. by 2 cm., and leaves the upper end of it connected with the anterior sheath. The lower end is brought into the abdominal cavity through the seventh intercostal space and is sutured to the greater curvature of the stomach by making a seromuscular-seromuscular canal over it. Finally, the free end of the aponeutoric strip is sutured to the round ligament of the liver. This operation accomplishes the following:

1. It diminishes the size of the stomach. The stomach is not hanging on a band as in some other methods, but is resting on it.
2. The pylorus and the first part of the duodenum lie in a straight line.
3. The evacuation of the gastric contents is rapid.

Technic.

Step 1. A midline incision is made through the skin and superficial

fascia extending from the ensiform process down to the umbilicus Two additional oblique incisions, also through the skin and superficial fascia, each of which is about five centimeters long, are made, one at each end of the vertical incision The flap (which consists of skin, superficial and deep fascia) is then reflected, and the anterior sheath of the rectus muscle is thereby well exposed

Step 2 An aponeurotic flap, 12 cm by 2 cm, is made from the anterior sheath of the left rectus muscle, having its base at the upper portion of the muscle The peritoneal cavity is now opened

Step 3 A small incision is made in the seventh left intercostal space close to the sternum The free end of the aponeurotic flap is caught by an artery-forceps brought from within the abdominal cavity through this small opening, and the flap is pulled into the abdominal cavity as far as possible

Step 4 The aponeurotic strip is placed along the greater curvature of the stomach, the highest point of which lies as high as is required by the position of the stomach Starting from this point the greater curvature is then sutured over the aponeurotic strip along the entire length of the greater curvature until the pyloric canal is reached

Step 5 The free end of the aponeurotic strip is sutured to the round ligament of the liver

Step 6 The abdomen is closed in tiers

Manuel Corachan, of Barcelona made a slight modification in the Lambret technic Instead of using a strip from the anterior sheath of the rectus muscle he uses a double thread of silk, one end of which he attaches to one costal arch and the other to the opposite costal arch The rest of the operation is the same as in the Lambret method

B Operations in which the stomach is fastened in its position either by strengthening its normally existing ligaments or by other intra-abdominal fixation

1 THE METHOD OF BEYEA BIER

This operation consists in pleating the gastro hepatic ligament It was first performed by Bier, in November 1897, in Kiehl However, the report of it was made only in 1900 Beyea performed his first operation in April, 1898, not being aware either of the work done by Duret or by Bier The technics of Bier and Beyea have a striking resemblance to each other

Technic

Step 1 The abdomen is opened

Step 2 A plaiting of the gastro-hepatic ligament is made in three or four places Each threaded needle takes three or four bites The first bite of each thread grasps the seromuscular layer of the stomach very close to the lesser curvature, then two or three bites grasp the gastro-

hepatic ligament, and the upper bite grasps the thickened capsule of the liver close to its transverse fissure (Fig. 195). The ends of the same thread are tied to each other.

Step 3. The abdomen is closed in tiers.

The advantage of this method is that the stomach is not attached to

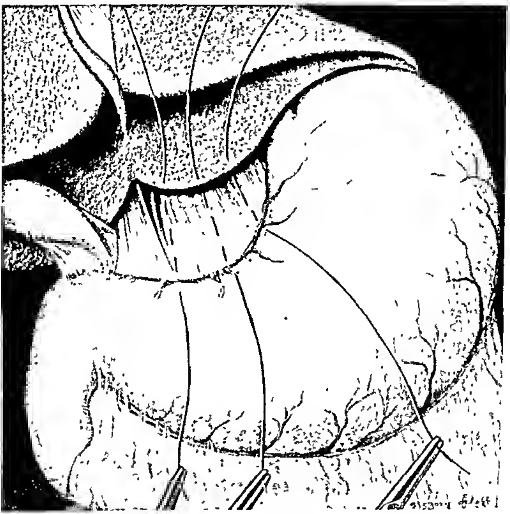

Fig. 195. Gastropexy. Beyea-Bier method.

the anterior abdominal wall and, therefore, no extensive adhesions are formed. However, the disadvantages are:

a. The danger of injury to the hepatic, left gastric and pyloric arteries, while doing the pleating.

b. Frequent recurrences of the gastroptosis on account of the thinness and weakness of the gastro-hepatic ligament.

In order to reinforce the pleated gastro hepatic ligament several methods were suggested

2 THE ROTHE METHOD

This was published in 1919 The pleated gastro hepatic ligament is reinforced by three strips of the fascia lata the size of which is about 5 cm by 1½ cm The technic is as follows

Step 1 A pleating of the gastro-hepatic ligament is made precisely as in the Beyea-Bier method

Step 2 Three small seromuscular flaps of a reversed U-shape (∩) are made on the anterior wall of the stomach very close to the lesser curvature These flaps are reflected downward A strip of fascia lata is sutured into each area of the exposed mucosa The U-flaps are turned back and sutured in their original position The free end of each strip is sutured to the lower surface of the liver, which is also scarified in order to make the attachment stronger

C OPERATIONS IN WHICH NOT ONLY THE STOMACH BUT ALSO THE COLON IS FIXED

THE WAUGH COFFEY OPERATION

As gastroptosis is frequently associated with ptosis of the cecum and of the ascending colon, Coffey suggested in such cases performing as a routine procedure a colopexy by the Waugh method and a gastropexy by his "hammock" technic

Technic

Step 1 The abdomen is opened through a midline incision

Step 2 A retractor is placed on the right lip of the abdominal wound which is retracted to the right The cecum is grasped and drawn medially An incision is made in the parietal peritoneum of the posterior abdominal wall one inch lateral to the cecum and the ascending colon The lateral lip of the parietal peritoneum is caught by an Allis forceps and detached from the underlying muscles of the posterior abdominal wall

Step 3 Three seromuscular bites are taken on the cecum, one just medial to the anterior longitudinal tænia coli, another through the tænia coli itself, and the third slightly lateral to it A fourth bite is taken through the lateral lip of the divided parietal peritoneum of the posterior abdominal wall This method of suturing starts at the lower angle of the wound by a series of interrupted sutures, and continues in an upward direction, at a distance of one half of an inch from each other until the hepatic flexure is reached Thus, the Waugh colopexy is completed

Step 4 The "hammock operation" is now performed in the following manner A bite is taken on the gastro colic ligament and another through the parietal peritoneum of the anterior abdominal wall at a point two

and a half inches above the umbilicus. The first stitch should be at the extreme left side of the transverse colon. The next stitch should run medially, and the distance between two bites should be not more than one-half to three-fourths of an inch, so that no loop of bowel can become incarcerated between the two successive stitches. This suturing is carried on until the right side of the gastro-colic omentum is reached.

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CHAPTER XVI

EXCISION OF A GASTRIC ULCER. EXCLUSION OF A GASTRIC ULCER. REPAIR OF A PERFORATED GASTRIC ULCER

1. EXCISION OF A GASTRIC ULCER

This is usually done when the ulcer is single and not of a large size. If, however, the ulcers are multiple or of a large size, a partial gastrectomy is the operation of choice.

Technic.

This operation is a simple procedure when it is done for removal of an ulcer on the anterior stomach-wall. When the ulcer is situated on the lesser curvature (and this is what actually happens in the great majority of cases), then the procedure is more complicated.

A REMOVAL OF AN ULCER ON THE ANTERIOR STOMACH WALL

Step 1. The abdomen is opened by a longitudinal or transverse incision.

Step 2. The stomach is walled off from the rest of the peritoneal cavity. A fold of the anterior wall of the stomach, which includes not only the ulcer but also the surrounding healthy tissues, is grasped by an intestinal clamp.

Step 3. The fold is cut away so that only a portion of the wall, about one-half inch, is left above the blades.

Step 4. The lips of the gastric opening are closed by two layers of sutures. One is an over-and-over, and the other, a seromuscular-seromuscular suture. [Before starting the seromuscular-seromuscular suture, the intestinal clamp releases the fold of the stomach.]

Many surgeons prefer not to use the clamps at all. Then, Step 2 will be as follows:

Step 2. The stomach is walled off from the rest of the peritoneal cavity. Two guy-sutures are placed in the healthy tissues of the stomach so as to facilitate the suturing, which will follow the incision of the diseased area. Two Allis forceps grasp the healthy tissues close to the diseased portion (Fig. 196). The stomach is cut between one of the guy-sutures and the adjoining Allis forceps. The tube of the suction-apparatus is then inserted into the stomach and its contents sucked out. The diseased portion of the stomach-wall, including also the adjoining healthy portions with the two Allis forceps attached to them, is cut away, leaving an opening into the stomach with a guy-suture at each end.

The rest of the operation is the same as Step 4.

B. EXCISION OF AN ULCER ON THE POSTERIOR STOMACH-WALL

There are three different methods of exposure of an ulcer on the posterior stomach-wall:

1. **Through a slit in the transverse mesocolon.**—The posterior wall of the stomach is pulled through a slit in the transverse mesocolon. This

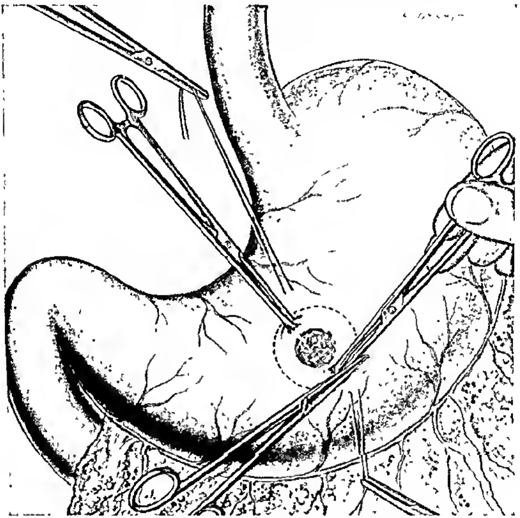

FIG. 196. Excision of an ulcer in the anterior stomach-wall.

method is applicable only in cases in which the ulcer is small and lies on that portion of the posterior stomach-wall which adjoins the "avascular area of Riolan" of the transverse mesocolon. The technic of excision of the ulcer is the same as described in the previous operation.

2. **By cutting the gastrocolic ligament and turning the posterior wall anteriorly (Fig. 144).**—While cutting the gastrocolic ligament care should be taken not to injure the middle colic artery, and the technical details of

this are already described elsewhere. The technic of excision of the ulcer is the same as in the previous operation.

3. The Transgastric method.—This consists in making an incision through the anterior stomach-wall, and then in the removal of a portion of the posterior stomach-wall with the ulcer. However, this method, although

Fig. 197. Excision of a gastric ulcer. Valla's technic.

still used occasionally, can hardly be recommended, since it is very easy to contaminate the lesser peritoneal cavity, and also because in suturing the posterior wall through the transgastric incision it is difficult to place a non-contaminated seromuscular suture.

C. REMOVAL OF AN ULCER ON THE LESSER CURVATURE (VALLA'S TECHNIC)

Step 1. The artery which runs along the lesser curvature is ligated in

two places, one inch distal and one inch proximal from the indurated area

Step 2 The gastro-hepatic ligament is cut for a length slightly greater than the distance between the ligated points of the artery

Step 3 Two intestinal clamps, the blades of which are covered with rubber tubing, are placed across the stomach in such a manner that one clamp lies proximal to the proximal point of the ligated artery and the other distal to the distal point of the ligated artery (Fig 197, insert) The clamps lie in such a manner that the posterior blades meet at an angle on the posterior wall of the stomach and the anterior blades at an angle on the anterior wall (Fig 197, insert) Thus, the two clamps separate a wedge-shaped portion of the stomach which contains the gastric ulcer from the rest of the stomach

Step 4 The "V"-shape portion of the stomach is cut away, leaving about one-half of an inch of the stomach-wall protruding from each clamp, which are then placed side-by-side (Fig 197, main picture) The two openings are sutured to each other precisely as described in the Chapter on "Lateral Intestinal Anastomosis"

Step 5 The opening in the gastric hepatic ligament is closed

II EXCLUSION OF A GASTRIC ULCER

This procedure is performed in cases in which the ulcer penetrates into one of the surrounding viscera (as the pancreas) and cannot be separated from it The operation consists in excising the ulcer from the stomach, leaving the ulcer connected with the pancreas, and suturing the opening in the stomach Thus, the ulcer becomes "extragastrectomized," as it were

These ulcers are usually located on the posterior gastric wall The approach to them is either through

1 The gastro-colic ligament, or

2 The anterior gastric wall

The technic of the operation differs somewhat depending on the route of approach

a In case of gastro-colic approach, the operation is as follows

Step 1 The gastro colic ligament is cut

Step 2 The greater curvature of the stomach is lifted so as to make the posterior wall face anteriorly

Step 3 A circular incision is made on the healthy portion of the posterior wall of the stomach surrounding the ulcer This will free the stomach from the surrounding structures when it can be fully reflected The ulcer is carefully and thoroughly disinfected

Step 4 The opening in the stomach is closed by two layers of sutures, the first being over-and over and the second seromuscular-seromuscular

Step 5. The lips of the gastro-colic ligament are sutured to each other.

b. In case of transgastric approach, the operation is as follows:

Step 1. After the abdomen is opened and the stomach is "walled off" from the rest of the peritoneal cavity, the anterior stomach-wall is opened

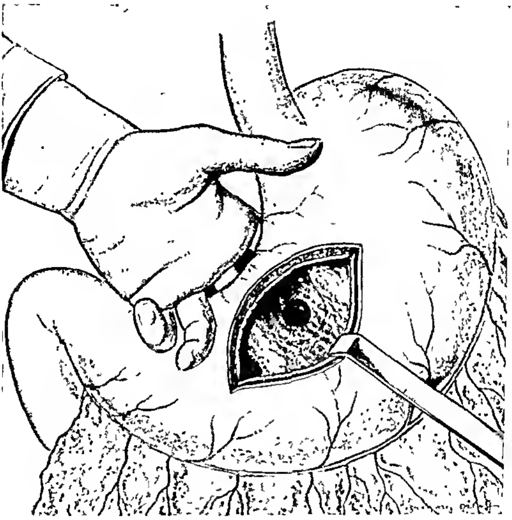

FIG. 198 Exclusion of a gastric ulcer on the posterior wall.

and its lips are separated from each other, thereby exposing the mucous surface of the posterior wall.

Step 2. A circular incision is made through the posterior wall of the stomach surrounding the ulcer, starting in the healthy mucosa at a distance of one inch from the edges of the ulcer (Fig. 198). In order to facilitate this cutting, the index- and the middle fingers of the left hand of the surgeon are introduced behind the posterior wall of the stomach (through

an opening made in the gastro-hepatic ligament) in such a manner that the index-finger lies to one side and the middle finger to the other side of the ulcer. The fingers lying behind the posterior wall of the stomach will prevent the possibility of injuring the pancreas while the cutting takes place. The surface of the ulcer is now thoroughly disinfected.

Step 3. The opening of the stomach is closed by a series of over-and-over mattress-sutures.

The "extragastrectomized" ulcer either absorbs or shrinks. Cases are reported in which patients so treated were clinically cured.

III REPAIR OF A PERFORATED GASTRIC OR DUODENAL ULCER

Step 1. After the abdomen is opened the stomach (or the duodenum) is walled off from the rest of the peritoneal cavity.

Step 2. An over-and-over suture is made penetrating the healthy tissues. If the indurated portion is too large it should first be excised. The number of sutures required for closure depends on the size of the opening. In ordinary cases of perforation, when the opening is very small, two sutures suffice. The sutures should be of an insoluble material such as linen or silk.

Step 3. The closed opening is covered either by the great omentum or by the gastro-hepatic ligament, depending on the location of the perforation.

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PART III

CHAPTER XVII

GASTRO-ENTEROSTOMY

Definition

The term GASTRO ENTEROSTOMY consists of three Greek words γαστηρ, stomach, ἔντερον, bowel and στόμα, mouth. It is an artificial communication between the lumen of the stomach and that of a bowel. If the communication is established between the lumen of the stomach and the duodenum, jejunum, ileum or colon, it is called respectively gastro-duodenostomy, gastro-jejunostomy, gastro ileostomy and gastro colostomy. When using the word gastro-enterostomy we usually presume that gastro jejunostomy is done. No one intentionally does a gastro ileostomy or a gastro colostomy, yet such procedures have been performed in error.

EVOLUTION OF GASTRO ENTEROSTOMY

The first gastro enterostomy was performed on Sept 28, 1881, by Anton Wolfler, at that time one of the assistants in the surgical clinic of Prof Billroth, in Vienna, at the suggestion of Prof Nicoladoni. Some writers believe that the idea originated with Villar and that Wolfler only first executed it. Wolfler made the anastomosis between the lumen of the stomach and one of the loops of the small bowel. He brought this loop in front of the omentum, the transverse colon, and the gastrocolic ligament, and sutured it to the anterior wall of the stomach, performing thus a gastro-enterostomy antecolica anterior, or the anterior gastro-enterostomy. This operation afforded good drainage for the stomach contents and was considered a successful operation, thus introducing a new surgical procedure.

There is hardly any operation in the entire field of abdominal surgery, which caused so many controversies as this operation, both from the standpoints of indications and of technic.

Indications

Some surgeons could hardly find any indications for its performance, advocating the use of some other operation, such as gastrectomy, jejunostomy or pyloroplasty.

Another group of surgeons suggested quite a wide field of indications for gastro jejunostomy and advocated its use in case of

1 Pyloric stenosis
2 Gastric ulcer
3 Duodenal ulcer

4. Hour-glass stomach.
5. Perigastritis.
6. Functional disturbances of the stomach.

Let us analyze each of the above enumerated group of indications:

1. Pyloric stenosis of benign origin in adults may be treated either by pyloroplasty, pylorectomy or gastro-enterostomy. In the United States, the majority of surgeons are performing gastro-enterostomy, although there is quite a large number who prefer one or another type of pyloroplasty or pylorectomy.

Pyloric stenosis due to malignancy should be treated by pylorectomy, if the case is still mechanically operable, and by gastro-enterostomy in the case in which pylorectomy is mechanicaly impossible.

There are many cases which are inoperable from the pathological point of view (metastasis to the liver, etc.), but mechanically it is still possible to make a resection (no adhesions to surrounding structures), and for such cases we believe pylorectomy should be given preference to gastro-jejunostomy.

2. Gastric Ulcer. The conservative group of surgeons are performing gastro-jejunostomy without excision of the ulcer. The more radical group perform gastro-jejunostomy with excision of the ulcer, and the most radical group prefer to perform a gastrectomy. In the United States, the majority of surgeons are performing a gastro-enterostomy with excision of the ulcer. In Continental Europe, and particularly in Germany, gastrectomy is the operation of choice.

3. Duodenal Ulcer. There is no unanimity of opinion in the handling of the duodenal ulcer. The conservative group of surgeons consider that duodenal ulcer should not be treated surgically at all. Only when complicatioos arise, such as perforation or hemorrhage, or when the ulcer does not yield to medical treatment employed for a considerahle length of time, should one resort to surgery. The less conservative group (and this, probably, is the majority) perform gastro-enterostomy without excision of the ulcer. The more radical group perform gastro-jejunostomy with excision of the ulcer, and the most radical perform either partial gastrectomy alone, or duodenectomy of the first part of the duodenum in combination with a partial gastrectomy. The majority of surgeons in the United States are performing gastro-jejunostomy without excision of the duodenal ulcer.

4. Hour-glass stomach. In the early days of gastro-jejunostomy many surgeons employed this operation to remedy this gastric condition. Nowadays, the majority prefer to employ a "sleeve resection" of the stomach.

However, in those rare cases in which the hour-glass stomach is adherent to its bed, so that gastrectomy is technically difficult or impossible to perform, it may be necessary to resort either to anterior gastro-enterostomy

with an entero anastomosis (Wölfler-Braun method), or to some type of gastro plastic operation (Wolfler or Kammerer type)

5 Perigastritis Some surgeons still use gastro jejunostomy for this condition but the more radical group prefer a partial gastrectomy Von Eiselsberg and his school believed that jejunostomy is the operation of choice for this condition There is still another group of surgeons who believe that for this condition the treatment should be purely medical

6 Functional disturbances of the stomach At the time when the indications for gastro enterostomy were numerous some surgeons advocated the use of gastro enterostomy for these conditions Now probably hardly any surgeon would perform gastro jejunostomy for these ailments

TECHNIC OF GASTRO ENTEROSTOMY

Many different methods of gastro enterostomy have been suggested These differ from each other depending on whether the jejunum is sutured to the anterior or the posterior wall of the stomach whether the incision in the stomach runs longitudinally obliquely or transversely whether it is located immediately above the greater curvature or higher up leaving a pouch and whether it lies on the antrum body or fundus of the stomach

There are methods in which the loop of jejunum is brought in front of the colon and sutured to the anterior wall of the stomach others in which the jejunum is brought in front of the colon and sutured to the posterior stomach wall others in which the jejunum is brought behind the colon and sutured to the posterior stomach wall and others in which the jejunum is brought behind the colon and sutured to the anterior stomach wall

Some methods were suggested in which the loop of the jejunum was taken very close to the duodeno jejunal junction and in others far away (16 to 24 inch) from this junction There are methods in which the incision in the jejunum runs parallel to its long axis and others in which the *incision runs perpendicularly to its long axis Also there are methods in* which the jejunum is completely severed in a direction perpendicular to its long axis and then the distal end of the severed loop is implanted into the stomach and the proximal end into the antimesenteric border of the distal loop

There are methods in which the gastro jejunostomy is supplemented either by a lateral intestinal anastomosis between the afferent and efferent loops of the bowel or by a gastrostomy And in addition to all the different methods already mentioned if we consider that each of them was performed either by a suture method or by the use of a mechanical appliance and if we remember that these mechanical appliances were numerous such as the Murphy button the Senn decalcified bone plates the Ramaugé

aluminum ring, the Abbé catgut plates, the Mayo Robson bobbin, the Penrose soft-rubber plates, the Brockow arteries of an ox, the Dawbarn potato plates, the Baracz turnip plates, etc., we can realize how many methods have been actually described.

In addition to all these methods a number of "aseptic anastomosis" methods have been suggested in which attempts were made not to open the lumen of the stomach or of the bowel at all. And finally, the introduction of the so called "relatively aseptic methods" greatly increased the number of the different methods suggested. However, of all this multitude of methods, only three or four have stood the test of time and are used today and these methods we will describe in detail.

The large number of gastrò-enterostomies suggested can be subdivided into two groups:

A. Anterior gastro-enterostomy.

B. Posterior gastro-enterostomy.

A. Anterior gastro-enterostomy.

This is characterized by suturing the jejunum to the anterior wall of the stomach.

The subdivisions of anterior gastro-enterostomy are:

1. The anterior antecolic antiperistaltic gastro-enterostomy (Gastro-enterostomia antecolica anterior antiperistaltica—the original Wölfler method).

In this variety, the jejunum is brought to the stomach in front of the transverse colon and placed in such a manner that its peristalsis runs in the direction opposite to the peristalsis of the stomach. This variety is now very seldom used.

2. The anterior antecolic iso-peristaltic gastro-enterostomy (Gastro-enterostomia antecolica anterior isoperistaltica—the Wölfler-Lücke-Rockwitz method).

This is characterized by placing the loop of the jejunum in front of the transverse colon on the anterior wall of the stomach in such a manner that the peristalsis of the stomach and of the jejunum move in the same direction. This variety is used now quite extensively in all cases in which anterior gastro-enterostomy is performed in combination with entero-anastomosis (Wölfler-Braun method).

3. Anterior retrocolic gastro-enterostomy (Gastro-enterostomia retrocolica anterior—the Billroth-Brenner-Brammann method).

This is characterized by making an opening in the transverse mesocolon and another in the gastrocolic ligament and bringing the loop of the jejunum through both openings and suturing it to the anterior wall of the stomach.

In this manner, the jejunum will not compress the colon anteriorly

and produce symptoms of low colonic obstruction This method is obsolete now However, in the pioneer days of gastro enterostomy it was used quite frequently

4 Gastro-enterostomia antecolica anterior by the "Y method" (the second method of Wolfler, Roux method)

This is characterized by a transverse division of the jejunum and an implantation of the distal open end of the jejunum into the stomach and of the proximal end of the severed jejunum into the lateral border of the distal loop of the jejunum

This method eliminates the occurrence of a regurgitant vomitus but introduces a new complication more frequently than in any other method, namely, the formation of a gastro jejunal ulcer

This method was first suggested by Wolfler, but commonly it is known as the Roux "Y method" It is seldom used now by any surgeon, but in the pioneer days of gastro enterostomy it was used quite frequently

5 Gastro-enterostomia antecolica anterior by the Chaput method

This method is characterized by a transverse division of a loop of the jejunum each end of which is closed blindly, then by making a lateral anastomosis between the stomach and the distal portion of the divided jejunum and then by making a lateral intestinal anastomosis between the proximal and the distal loops of the divided jejunum

The object of this operation was to prevent the possibility of regurgitant vomitus and to obviate the more difficult technic of making an end to side anastomosis This operation is obsolete

6 Anterior antecolic gastro-enterostomy with an entero-anastomosis (Wolfler-Braun method)

This method consists in making an anterior gastro jejunostomy and in supplementing this at the same sitting by a lateral intestinal anastomosis between the afferent and efferent loops of the bowel

The object of this method is to obviate the possibility of a regurgitant vomitus since should the food pass from the stomach into the afferent loop, it will then change its direction and enter the efferent loop as soon as it reaches the stoma between the two loops of the bowel (Fig 209)

This method, namely, the Wolfler-Braun method, is the best operative procedure in all cases in which anterior gastro-enterostomy is indicated, and is considered as the standard operation

B Posterior gastro-enterostomy (Gastro-enterostomia posterior)

This is characterized by suturing the jejunum to the posterior wall of the stomach The subdivisions of posterior gastro-enterostomy are

1 Posterior retrocolic gastro-enterostomy (Gastro-enterostomia retrocolica posterior—Courvoisier method)

This method is characterized by making one opening in the transverse

mesocolon and another in the gastro-colic ligament, and by bringing the loop of the jejunum through both openings and suturing it to the posterior wall of the stomach.

Courvoisier, indeed, is the originator of the posterior gastro-enterostomy.

This method is obsolete.

2. **Posterior retrocolic gastro-enterostomy (Gastro-enterostomia retrocolica posterior—Von Hacker method).**

This method is characterized by making an opening in the transverse mesocolon, then by pushing the posterior wall of the stomach through this opening into the general peritoneal cavity, and then by suturing a loop of the jejunum to this protruded posterior wall of the stomach.

In this method the gastro-colic ligament is left intact.

3. **Posterior antecolic gastro-enterostomy (Gastro-enterostomia antecolica posterior—Hall method).** Described in 1902. In this method gastro-colic ligament is divided for a length of three or four inches and a loop of jejunum is brought in front of the transverse colon and sutured to the posterior stomach wall.

4. **Gastro-enterostomia retrocolica posterior with a very short jejunal loop (Petersen method) and with the incision on the stomach running either in an oblique direction (Mayo method) or in a vertical direction (Moynihan method).**

Posterior gastro-jejunostomy is done now by nearly all surgeons by this method.

In order to understand the stimuli which moved the surgeons to search for new methods and for improvements of the old ones, let us analyze the complications which arose from time to time after the performance of a gastro-enterostomy. These complications were:

1. Surgical shock.
2. Peritonitis.
3. Hemorrhage.
4. Inanition.
5. Regurgitant vomitus ("Vicious circle").
6. Post-operative gastro-jejunal ulcer.
7. Internal strangulation of the bowel:

a. Due to the non-closed slit of the transverse mesocolon.

b. Due to the suturing of the slit of the mesocolon to the jejunum or to the anastomotic line.

8. Retrograde intussusception into the stoma.
9. Formation of a gastro-jejuno-colic fistula.
10. Gastro-enterostomy disease.

1. **Shock.** This was the most frequent cause of death in the pioneer days

of gastro enterostomy Nearly fifty per cent of all cases of death were due to shock following the operation

The main reason for this was that the patients were operated upon when they were already in a bad condition Another reason was that the technic was very crude The handling of the tissues was not gentle [in order to find a high jejunal loop, nearly the entire length of the small bowel was handled] The pre-operative management consisted, among other things, in the administration of a great number of cathartics, thus increasing the further dehydration of the patients With the improvement in the surgical technic and in the pre-operative preparation of the patients this cause of death became practically *nil*

2 Peritonitis was second in frequency as a cause of death Nearly twenty five per cent of all deaths were attributed to this cause Undoubtedly, the percentage of death due to peritonitis was much higher, since in many cases in which the death was attributed to shock peritonitis was also present It is not to be wondered at that peritonitis was of such frequent occurrence At that time antiseptic methods were in vogue, the greatest importance being laid on the use of the phenol spray for the prevention of infection The importance of using strictly sterile instruments and sponges was not yet appreciated The stomach or intestinal clamps were used infrequently, and the escape of the gastro-intestinal contents was, therefore, quite frequent The importance of "walling off" the opened stomach and bowel from the peritoneal cavity was not yet appreciated and, therefore, the contamination of the abdominal cavity by the escaped contents was of common occurrence

But with the advent of the "aseptic period" in surgery, which replaced Listerism, with the introduction of the stomach- and intestinal clamp, thus minimizing the possibility of escape of the gastro-intestinal contents, the possibility of peritonitis was greatly diminished Barker, in 1886, and Lauenstein, in 1888, still further minimized the possibility of contamination of the peritoneal cavity by introducing a simple technical device, namely, by making a seromuscular suture between the stomach and the bowel before the lumina of these viscera were opened Finally, the "walling off" of the exposed stomach and of the selected loop of jejunum from the rest of the peritoneal cavity still further minimized the occurrence of peritonitis, so that now peritonitis very seldom occurs

3 Hemorrhage Hemorrhage today is of infrequent occurrence If it occurs, it may come

a From the suture-line of the anastomosis

b From the gastric or duodenal ulcer which was not removed

c From the mucosa of the stomach

a The most frequent cause of hemorrhage is bleeding from the su-

ture-line of the anastomosis. The reason for this is that not all the blood-vessels were ligated or caught by the suture. This especially may occur when each individual blood-vessel is not ligated separately but is caught in the continuous suture which penetrates either the mucosa or the entire thickness of the stomach.

This condition may be remedied in two ways: Either the surgeon ligates the blood-vessels with a threaded needle, penetrating the mucosa after the seromuscular layer is incised (Haberer), or he releases the clamps holding the stomach before the mucosa is sutured and then clamps each bleeding vessel individually (Enderlen).

b. Bleeding from a gastric or duodenal ulcer which was not resected when the gastro-enterostomy was performed has been recorded by some surgeons. However, it is rather an infrequent occurrence.

c. Bleeding from the mucosa has been reported several times. Some surgeons blamed the use of stomach-clamps applied on the stomach while the gastro-enterostomy was performed. It occurred, however, just as frequently in cases in which clamps were not used and, therefore, the clamps cannot be blamed for this condition. Some believe that it is due to the change in the mutual relationship between the intragastric and intra-abdominal pressure (Spasokukotzki).

4. Inanition. In the early days of gastro-intestinal surgery, the surgeons did not know how to find one of the upper loops of the jejunum and, for this reason, they sutured to the stomach any loop which they considered as an upper jejunal loop. Consequently, errors were very frequent, and cases were reported, even by the most eminent surgeons, in which the autopsy revealed that the stomach was sutured either to a lower loop of the ileum or even to the transverse colon. In such cases, the greater portion of the small bowel was eliminated from participation in the digestive action of the alimentary tract, and the patients, after recovering surgically, succumbed in a short time (two to three months) with symptoms of starvation.

This demonstrated very conclusively the necessity of elaborating a method of locating one of the upper loops of the jejunum.

Different methods of doing this were suggested, but they were not reliable until A. Wölfler advised searching for the duodeno-jejunal plica. The method which he suggested is employed with slight modification to-day. (The description of this method can be read in Chapter III, under the name "Wölfler-Socin rule.")

This eliminated the occurrence of inanition. The surgeons would usually use a loop of the bowel 16 to 24 inches away from the duodeno-jejunal junction, bring it in front of the transverse colon, and suture it to the anterior stomach-wall. However, occasionally, difficulties were encountered.

In some cases, the mesojejunum was very short, and it was either difficult or even impossible to bring the jejunum in front of the transverse colon Cases were described in which the jejunum compressed the colon and produced intestinal obstruction In other cases the suture-line between the stomach and the jejunum was under so great a tension that it gave away, thus producing a fatal peritonitis

It was a stroke of genius when Courvoisier, in 1883, suggested overcoming this difficulty by making one opening in the transverse mesocolon and another in the gastrocolic ligament, and by bringing a loop of the jejunum behind the colon into the lesser peritoneal cavity and from there again into the general peritoneal cavity, and by then suturing the loop of the jejunum to the posterior wall of the stomach

In this manner it became possible to make an anastomosis between the stomach and a loop of the jejunum irrespective of whether its mesentery was long or short Thus, Courvoisier is the originator of the posterior gastro-enterostomy

The operation, however, did not appeal to the surgeons, until Von Hacker, in 1885, introduced two essential improvements in the Courvoisier method He made a longitudinal slit in the transverse mesocolon, instead of the transverse slit which was used by Courvoisier with a possible injury to the important branches of the middle colic artery He showed that it was not necessary to cut the gastrocolic ligament, but that the posterior wall of the stomach can be pushed down from the lesser into the greater peritoneal cavity, and thus the anastomosis can be accomplished below the transverse mesocolon

This method, namely, the Von Hacker's variety of posterior gastro-enterostomy, was generally accepted by the profession, and it began to compete successfully with the older method, anterior gastro enterostomy

While this method was frequently used, facts were accumulating which showed that it should be preferred to anterior gastro-enterostomy, so that finally it replaced anterior gastro-enterostomy and has now become the operation of choice

These facts will be discussed more fully when another complication of gastro-enterostomy, namely the regurgitant vomiting ("vicious circle"), is analyzed

5 The Vicious Circle This term was coined by Mikulicz

This was one of the most dreaded complications of gastro-enterostomy It was not as frequent a complication as some others However, it took *more time to learn how to overcome this than many other complications of* gastro-enterostomy

The first incidence of a "vicious circle" occurred in the second case of gastro-enterostomy performed on a patient operated upon by Billroth

According to the rapidity of its clinical manifestations it is differentiated thus:

a. Acute Vicious Circle. It is this type of uncontrollable vomiting which, if not relieved surgically, leads to death in a few days.

b. Chronic Vicious Circle. This term was coined by Finsterer. To this group belong the cases in which the vicious circle lasts for months.

c. Late Vicious Circle. This term was coined by Brunzel. It is applied to those cases of vicious circle in which the symptoms appear for the first time many months or even years after the gastro-enterostomy was performed.

As mentioned above, the term "vicious circle," was coined by Mikulicz. He thought that there was only one way for its formation, namely, that the food passed through the stomach into the afferent loop, then passed backward into the jejunum, duodenum, pylorus, and then into the stomach, then again from the stomach into the afferent loop of the jejunum, duodenum, and so on. He also considered another possibility, namely, that the food passed from the stomach through the pylorus, duodenum, afferent loop of the jejunum into the stomach, then again through the pylorus, and so forth.

This explanation is correct for some cases. However, in many cases the persistent vomiting occurred even when the pylorus was cut transversely and both severed ends were closed entirely. This showed that the term "vicious circle," is not correct, and that the name "regurgitant vomitus," which is used in English-speaking countries, is more appropriate. Evidently, there is not a single cause which produces the regurgitant vomitus. Many other causes, according to investigators, are responsible for this condition, namely:

A. Spur-formation. Some surgeons consider this as one of the causes of vicious circle. Different technical errors may produce a spur:

a. A short length of the suture-line between the stomach and the jejunum. Under such circumstances, both ends of the intestine hang vertically down. Thus, a spur may be formed. The size of this spur may be increased by traction of the mesentery. In order to remedy the abrupt hanging down of the jejunum, Hadra, in 1891, advised suturing the jejunum to the wall of the stomach on each side of the gastro-jejunal opening by a seromuscular suture.

b. Improper site for the suture.

If the portion of the jejunal wall lying very close to its mesenteric border is utilized for anastomosis with the stomach, then the possibility of a spur-formation at the site of the anastomosis is increased. For this reason, it is considered best to make the seromuscular suture one-sixth of an inch away toward the inner side of the antimesenteric border, to

make the incision leading into the bowel on the antimesenteric border, and to make the anterior seromuscular suture line one-sixth of an inch lateral to the antimesenteric border

The correction of these faults, however, did not eliminate the occurrence of regurgitant vomiting

This proves that if spur formation may be the cause of regurgitant vomiting in some cases, there are, however, many other causes which may produce it

B Some believed that placing the stomach and a loop of the jejunum in an antiperistaltic direction may produce regurgitant vomiting, and for this reason advised placing them in the isoperistaltic direction (Wolfler-Lücke-Rockwitz method)

C Recently, it was suggested by Kasper Blond that the cause of vicious circle in many cases is a temporary spasm of the stoma This theory has many followers

D However, the majority of surgeons believe that technical errors may be the predisposing factor, and that the deciding factor is that the food is entering the afferent instead of the efferent loop For this reason many ingenuous methods have been devised to prevent the passage of the food from the stomach into the afferent loop It must be admitted that probably the greatest help in this direction is afforded by nature itself, namely by the peristaltic movements of the bowel, which produce a suction action into the efferent loop and thus, so to speak, invite the passing of the food from the stomach into this loop

This is the reason why, in spite of the fact that so many technical errors are made, the food usually passes into the efferent loop and cases of regurgitant vomiting are rare compared to the great number of gastro enterostomies performed

However, in order to diminish the possibility of the food passing in the wrong direction, many surgeons tried to constrict the afferent loop Thus Wolfler, in 1883, placed a circular purse string around the mouth of the afferent loop and moderately constricted its lumen

Von Hacker, in 1892, narrowed the mouth of the afferent loop in a manner similar to that of Wolfler with the difference only that instead of making a purse-string, as Wolfler did, he introduced a few interrupted sutures, thus producing folds of mucosa which projected into the lumen of the afferent loop thereby diminishing it

T Kocher, in 1894, suggested the following method A loop of jejunum was placed transversely on the lowermost portion of the stomach In this manner the afferent loop of the jejunum lay behind the efferent loop A seromuscular suture was made between the stomach and the efferent loop of the jejunum Then an incision was made through the entire thickness of

the stomach-wall and of the wall of the efferent loop of the jejunum [on the jejunum the length of the incision was about half of the circumference of the bowel] and the lips were sutured together. Thus, an anastomosis was made between the stomach and the efferent loop of the jejunum.

The objection to all these methods of constricting the afferent loop is that if the narrowing is not considerable, the food can still pass into the lumen of the afferent loop. If the lumen is markedly constricted, it prevents a free flow of the bile and pancreatic juice from the afferent into the efferent loop.

A decisive step forward in the prevention of the development of regurgitant vomiting was the method of Doyen:

An opening was made in the gastrocolic ligament, and the great omentum was carried through this into the bursa omentalis. The transverse colon was then sutured to the anterior wall of the stomach immediately above the greater curvature. Then, one of the proximal jejunal loops was sutured to the anterior wall of the stomach by a seromuscular suture for a length of 10 to 12 cm. in an oblique direction, so that the proximal portion of the loop was placed higher than the distal portion. Then, an anastomosis was made between the stomach and the sutured loop of the jejunum for a length of four cm. The openings in the stomach and in the jejunum were placed in the center of the sutured seromuscular line. In this manner, the afferent loop lay higher than the efferent loop.

In order to diminish still further the possibility of food passing into the proximal loop of the jejunum, the latter was constricted by inserting a few Lembert sutures, so that longitudinal mucous folds were formed, which diminished the lumen of the afferent loop of the jejunum.

Thus, Doyen initiated the idea of making an ascending and a descending loop rather than a right and a left loop, an idea, which was further developed later by Czerny and his school (Petersen), and which ultimately made regurgitant vomiting a rare occurrence.

Lauenstein, in 1891, proposed supplementing anterior gastro-enterostomy by an entero-anastomosis between the afferent loop of the jejunum and any other jejunal loop situated distal to the gastro-jejunal stoma.

This supplementary entero-anastomosis prevents the occurrence of regurgitant vomitus, since in case the food passed into the afferent instead of the efferent loop it meets in its further advancement the stoma between these two loops. Then it changes its direction, and instead of passing further in the afferent loop against the peristaltic waves, passes into the efferent loop where its passage is facilitated by the isoperistaltic movements of this loop.

Jaboulay, in 1892, suggested supplementing gastro-enterostomy by a duodeno-jejunostomy, making a lateral intestinal anastomosis between the

duodenum and the efferent loop of the jejunum a few inches away from the gastro-jejunal stoma

The idea is the same as that of Lauenstein Its advantage over the method of Lauenstein is that in the latter method of entero anastomosis, the loop of the bowel used for this purpose could be at a considerable distance from the gastro-jejunal stoma, and thus an intestinal exclusion of a loop of a bowel of a considerable length might be produced

Braun, in 1893, suggested making the entero anastomosis between the two jejunal loops at a distance of about four inches away from the gastro-jejunal stoma (Fig 209)

The suggestion of Lauenstein passed nearly unnoticed However, the method of Jaboulay and that of Braun attracted the attention of the profession and surgeons began to use them, at first, merely as a supplementary operation only for such cases in which after completion of the gastro enterstomy symptoms of vicious circle appeared Later, instead of doing Braun's entero-anastomosis as a re operation, it became a routine procedure to make the entero-anastomosis a regular step in every case of anterior gastro-enterostomy (Wolfler-Braun method)

This supplementary step, namely Braun's entero-anastomosis is the most frequently employed method in cases in which anterior gastro-enterostomy is performed However, several other methods have been proposed in order to avoid the occurrence of the regurgitant vomitus

Thus, Wolfler suggested cutting a loop of the jejunum transversely and implanting the distal end of the severed loop into the anterior wall of the stomach and the open end of the proximal loop into the lateral side of the distal loop

This suggestion was carried out by Roux and is known as "Roux's Y gastro enterostomy" Another name for this method is "The second method of Wolfler"

Chaput utilized this idea in the following manner A loop of the jejunum was cut transversely and both ends were closed blindly Then, a lateral anastomosis was made between the stomach and the distal loop, and another lateral anastomosis between the proximal and the distal loops of the jejunum

Witzel suggested his method An anterior gastro enterostomy was performed and this was supplemented by a Witzel type of gastrostomy A rubber tube was passed then through the gastrostomy channel into the lumen of the stomach and then farther on through the stoma into the efferent loop The patient was fed through the rubber tube, which assured the passage of the food into the efferent loop After a few days the rubber tube was removed This method is called "gastro-enterostomy with a gastrostomy" ("gastro-enterostomia cum gastrostomia")

Sonnenburg suggested, in 1894, the following method:

An incision was made along the free border of the jejunum for a distance of two and one-half to three inches. Hemorrhage from the lips of this incision was checked by buttonhole-sutures which penetrated the entire thickness of the jejunal wall.

Another incision was made on the stomach the length of which was slightly less than that on the jejunum, and the lips of this incision were also sutured by buttonhole sutures: The ends of the thread were left long in at least three places. Then another incision was made about two cm. distal from the first incision on the jejunum, the length of which was about one-half of an inch. The ends of the thread left long on the stomach were introduced into the lumen of the jejunum through the large jejunal opening and then brought outside through the smaller jejunal opening. The threads were drawn tight, so that the stomach around its opening was wedged into the lumen of the efferent loop of the jejunum. A seromuscular suture was made between the stomach and the jejunal wall surrounding the larger jejunal-opening. The ends of the thread from the stomach protruding through the smaller jejunal opening were cut short, and this opening was closed in the usual manner.

Thus, the stomach was wedged into the efferent loop of the jejunum, thereby making impossible the escape of food into the proximal jejunal loop.

In 1900, Walter Petersen, assistant in the surgical clinic of Prof. Czerny, at Heidelberg, gave his explanation of the causes of regurgitant vomiting. This was, in fact, the expression of thought of his master, Czerny, in Germany, and of Doyen, in France. He showed that regurgitant vomiting occurred just as frequently in the operation of posterior as of anterior gastro-enterostomy. Regurgitant vomiting was a rare occurrence only in those clinics in which the usual operation was a posterior gastro-enterostomy with a very short loop. Since usually the duodeno-jejunal junction lies at a higher level than the most dependent portion of the stomach, and since the stoma of the gastro-enterostomy is usually situated on the most dependent part of the stomach, the afferent loop always has an ascending direction and the efferent loop a descending direction from the stoma. Food will pass according to the law of gravity into the efferent loop.

In the case of an anterior gastro-enterostomy, the afferent loop should always be a long one, otherwise, it will compress the colon and produce an intestinal obstruction. If a long loop is taken, then there will be no ascending or descending loop, but a right and a left loop. The food will have a tendency to pass into the efferent loop, but if any, even the slightest, obstruction of the efferent loop occurs, the food will pass through the stoma into the afferent loop which may become distended and compress

the efferent loop, and thus produce symptoms of regurgitant vomiting.

This makes it clear that since a short loop is an essential condition for the elimination of a vicious circle, and since a short loop can be used only in the case of a posterior gastro-enterostomy, the posterior gastro-enterostomy should be the operation of choice.

To recapitulate:

To obviate the occurrence of the regurgitant vomiting it is necessary to fulfil the following requirements:

a. The posterior gastro-enterostomy should be the operation of choice.

b. The stoma should be placed as low as possible, so that it will lie lower than the duodeno-jejunal junction.

c. The loop should be taken as close as possible to the duodeno-jejunal junction without undue tension. Then, the afferent loop will be the ascending and the efferent the descending loop.

d. All other technical errors, such as spur-formation should be eliminated.

As an indirect, but quite a convincing, proof of the correctness of the belief of the importance of having a short loop is the fact that since surgeons began to use this "short or no loop method," the occurrence of vicious circle has become very rare.

Although the introduction of a very short loop eliminated nearly entirely the occurrence of the regurgitant vomiting, this does not prove that the vomiting is due to the formation of an ascending and a descending loop. We believe that by the usual method of performing a posterior gastro-enterostomy with a short loop, it is impossible to make an ascending and a descending loop. Evidently something else occurs which actually eliminates the possibility of the regurgitant vomiting.

However, there are cases in which it is impossible to perform a posterior gastro-enterostomy. These occasions are:

a. A very short transverse mesocolon.

b. A very vascular transverse mesocolon so that it is impossible to find an avascular area of sufficient size.

c. A very thickened transverse mesocolon, so that it is difficult to see the exact arrangement and distribution of the blood-vessels.

d. Adhesions between the posterior wall of the stomach and the posterior abdominal wall, so that it is difficult to deliver the posterior gastric wall into the greater peritoneal cavity.

e. Pathological changes of the posterior stomach-wall which makes it unsuitable for a gastro-intestinal anastomosis.

Under such conditions, it is necessary to perform an anterior gastro-enterostomy, which means that a long loop of jejunum should be taken, and hence there is a possibility of the development of the symptoms of

regurgitant vomiting. In order to exclude this possibility several methods were proposed, the details of which have been described above and the best of which is the Wölfler-Braun method.

Thus, we may recapitulate:

Of all the methods of gastro-enterostomy, posterior gastro-enterostomy by a short or no-loop method is the operation of choice.

If this cannot be done, then an anterior gastro-enterostomy with entero-anastomosis (Wölfler-Braun method) should be performed.

6. Post-operative gastro-jejunal ulcer.—This complication occurs from time to time. The first case was reported, in 1897, by Berg. Denk, in 1920, collected from the literature to that date, 309 cases. This complication is usually observed in the first six months after the gastro-enterostomy was performed. Some estimate this incidence as low as two per cent and others as high as thirty per cent. On the average, the occurrence is about four per cent.

In some cases this complication is the result of faulty technic, being due to careless suturing of the mucosa, so that the acid gastric contents pour onto the muscularis, thus producing ulcers.

However, in many instances this complication is due to the unsatisfactory selection of cases. In persons living the "high tension" life, and in neurotics whose medical treatment did not relieve them, this complication is more frequently met with than in the asthenic, phlegmatic type of patients.

In the last few years, Kasper Blond suggested a theory the essence of which is that in the neurotic or the "sthenic" type of people very frequently a spasm of the stomach involving the gastro-jejunal stoma occurs after a gastro-enterostomy has been performed, thus compressing either the gastric lip or the jejunal lip of the stoma. This produces a temporary ischemia of the lips and they become then easy victims of the digestive action of the gastric juice with an ensuing gastro-jejunal peptic ulcer.

Many investigators believe in the correctness of this theory, and they advise the prescribing of tincture of belladonna for this type of patient for a short time after the gastro-enterostomy has been performed.

7. Internal strangulation of the bowel.—This was one of the earliest complications following the performance of posterior gastro-jejunostomy.

Von Hacker suggested, as early as 1885, the elimination of this complication by suturing the stomach to the edge of the opening in the transverse mesocolon before performing the gastro-jejunostomy.

This original maneuvre of Von Hacker was later changed by many surgeons who performed the gastro-enterostomy first and then sutured the edges of the opening in the transverse mesocolon to the wall of the stomach.

Lewis L. McArthur modified this method by suturing first the posterior

wall of the stomach to the lower edge of the opening in the transverse mesocolon, then performing the posterior gastro-enterostomy, and then suturing *the anterior edge of the opening in the mesocolon to the posterior* wall of the stomach We consider this procedure the best

Some surgeons advocated suturing the edges of the mesocolon to the jejunum In this manner the gastro jejunal suture line was thrown into the lesser peritoneal cavity Others sutured the posterior wall of the stomach to the lips of the mesocolon at a distance of one fourth of an inch away from the edges of the mesocolon, and then sutured these edges to the jejunum, thus peritonizing the gastro jejunal suture line

The last two methods are unsafe, since cases have been recorded in which adhesions have been formed and extended from the edges of the transverse mesocolon, compressing the soft wall of the jejunum and producing an intestinal obstruction The same adhesions, if they should compress the strong stomach wall, would not be able to produce an obstruction

8 Retrograde intussusception of the small bowel through the stoma into the stomach, or progressive intussusception of the stomach into the jejunum through the stoma

The first case of retrograde intussusception was published by Steber, in 1917 Since that time up to date more than thirty such cases have been reported There is no doubt that many cases that were diagnosed as an acute form of vicious circle actually were cases of invagination which occurred a few days after the operation was performed Many cases of "chronic vicious circle" were actually cases of invagination which would from time to time spontaneously reduce then reappear, etc This group of symptoms occurs after either anterior or posterior gastro enterostomy has been performed It has occurred as early as the sixth post-operative day and as late as 15½ years after the operation The average time for the appearance of this condition is seven years

The symptoms of this condition are those of a high intestinal obstruction A bloody vomiting together with symptoms of a high intestinal obstruction, and a history of a previously performed gastro enterostomy, make the diagnosis highly probable

The etiological factors producing this condition are not clear In the last few years many believe in the correctness of the theory suggested by Kasper Blond, namely, that this condition, as also the origin of the gastro-jejunal peptic ulcer, is due to temporary spasm of the jejunum

The operative treatment of this condition is described in the last part of this chapter

All cases of invagination through the gastro jejunal stoma can be subdivided into two classes

a. Ascending invagination.

b. Descending invagination.

a. The ascending invagination is the variety in which the jejunum enters into the lumen of the stomach; the majority of cases described are of this variety. The variations of this type which have been observed are:

1. Invagination of the afferent loop.
2. Invagination of the efferent loop.
3. Invagination of both afferent and efferent loops.

b. Descending invagination is the variety in which the stomach is invaginated into one of the jejunal loops. There are also varieties of this form:

1. Invagination of the stomach into the afferent loop.
2. Invagination of the stomach into the efferent loop.

9. The gastro-jejuno-colic fistula.—The first who observed and operated for a gastro-jejuno-colic fistula was Kaufmann. Brock, in 1924, was able to report 216 cases of gastro-colic fistula, 91 of which were of a postoperative origin. The diagnosis of this condition is easily established both clinically and roentgenologically. The treatment of this condition is purely surgical.

The operative management may be:

a. Conservative. This consists in the disengagement of the stoma and closure of the stomach, the wall of the colon and of the jejunal-wall (if the jejunum is involved).

b. Radical. This consists in resection of the fistula, including a part of the stomach-wall, and a portion of the colon and of the afferent and efferent loops of the jejunum (if the jejunum was involved).

10. Gastro-enterostomy disease. Many surgeons, particularly of Continental Europe, have described a condition following gastro-enterostomy which is characterized by a variety of symptoms, of which one or another may be predominant in the individual patient. These symptoms consist of pain in the epigastric region, regurgitant vomiting (mostly of bilous contents), and belching.

There is no doubt that several other pathological conditions have appeared as sequelæ of gastro-enterostomy, such as peptic gastrojejunal ulcer, regurgitant vomiting, retrograde invagination of the jejunum through the stoma into the stomach, spasm of the stoma (which includes the stomach-wall and the loops of the jejunum, either the afferent or the efferent or both of them), have been confused with gastro-enterostomy disease. Nevertheless, if all cases due to the above mentioned causes be excluded, there still are left a number of cases which exhibit the above enumerated symptoms and in which on re-operation no changes are found in the stoma.

These cases are cured by a mere degastro-enterostomy. They usually occur in patients upon whom gastro enterostomy should not have been performed at all (such as cases of functional disorders of the stomach, or cases in which the surgeon expected to find a gastric or a duodenal ulcer, and not finding this, made a "prophylactic gastro-enterostomy") The presence of gastro-enterostomy disease in the greatest majority of cases is not a sign of poor surgical technic but of an improper indication for a gastro-enterostomy

However, some investigators (Pribram) believe that even if the indications for gastro-enterostomy were correct and the ulcers healed, the patient may develop "gastro enterostomy disease" if the pylorus remains patent In this fact they see the reason why a gastro enterostomy should not be employed for the treatment of gastric or duodenal ulcer, instead of which they advocate the performing of a partial gastrectomy

SITE OF THE STOMA

In the early days of gastro enterostomy there were numerous discussions as to where the stoma should be placed, whether on the body or on the antrum of the stomach

Investigations carried out by Georg Kelling, in 1900, and which were confirmed later by several other investigators, showed that if the stoma is placed on the body of the stomach, the flow of the contents through the stoma is continuous, whereas, if it is placed in the antrum, the flow is intermittent

Since the chief indication for the performance of a gastro enterostomy is to secure a good drainage of the gastric contents, it is evident, that it is better to place the stoma at a point where the drainage will be continuous and where the stomach will make no great effort to evacuate the food For this reason the stoma should be placed on the body of the stomach As a rule, it should be placed on the healthy portion of the wall of the stomach and always proximal to the site of the ulcer

HOW FAR FROM THE CURVATURES SHOULD THE STOMA BE PLACED?

There were numerous discussions as to whether the stoma should be placed closer to the lesser or to the greater curvature The majority of surgeons agree that it should be placed as close to the greater curvature as is possible, since it then affords the best drainage with but little effort

This gives the stomach more rest than if the stoma is placed higher up, and rest of the stomach will accelerate the healing of the ulcers.

On the bowel, the opening should be made on the anti mesenteric border (This suggestion was first made by Hahn)

However, some surgeons believe that the opening of the bowel should be placed somewhat closer to the mesenteric border

WHAT SHOULD BE THE LENGTH OF THE INCISION ON THE STOMACH AND ON THE JEJUNUM?

There have been different opinions as to this. Some consider that it should be as long as four inches and some as short as ooe and a half inches. In order to facilitate tbe passage of the contents of the stomach into the howel, the size of the exit from the stomach should he equal to the size of the entrance into the bowel. The size of the eotrance into the bowel is represented by the size of the diameter of an upper jejuoal loop, namely it is about ooc and a half inches. However, the opening of the stomach should be larger than one and a half inches, since the mouth of the affereot loop is also eonnected with the openiog in the stomach. On deciding on the size of the incision on the stomach it should also he considered that the newly formed stoma has a tendency to contract. For these reasons, it seems advisahle to make the length of the stoma between two and a half aod three inches.

HOW SHOULD THE STOMACH AND JEJUNUM BE PLACED—IN THE ISOPERISTALTIC OR IN THE ANTIPERISTALTIC DIRECTION?

This is quite a debatable subject even today. Some surgeons consider that the stomach and the loop of the jejunum should be placed in an isoperistaltic direction. Others consider that they should be placed in an antiperistaltic direction. Many consider it immaterial in which way they are placed. Wölfler, in his first operation, placed them in an antiperistaltic direction, and later on, due to frequent occurrences of the vicious circle, ho suggested placing them in an isoperistaltic direction, and this method is knowo, as already mentioned, as the Wölfler-Lücke-Rockwitz method.

It seems to us that in the case of an anterior gastro-enterostomy it is immaterial whether the stomach and the jejuoum are placed in an isoperistaltic or io an antiperistaltic direction for the following reasons:

The works of Halsted, Mall and maoy other iovestigators oo reverse peristalsis showed cooclusively that the peristaltic waves do oot depend on the contiouity of the segments of the howels, hut that they do depend on the intrinsic nervous apparatus located io the wall of the bowel itself.

Therefore, no matter how the jejuoum may he placed in relation to the stomach, the movement of the food going into the efferent loop will always be facilitated by peristaltic movements, and in the affereot loop will always be hiodered by antiperistaltic waves. The main thing is to place the jejuoum in relatioo to the stomach in such a manner as to secure the passage of the food from the stomach into the effereot loop and oot into the affereot loop.

How to accomplish this has already heeo discussed aod will again be presented under the "Technic of anterior gastro-enterostomy" aod of the "Technic of posterior gastro-enterostomy."

However, in performing anterior gastro-enterostomy we believe that it is best to place the stomach and jejunal loop in the isoperistaltic direction (Wölfler-Lücke-Rockwitz method) not because the placing of the bowel will influence in one or another way the possibility of regurgitant vomiting, but because it eliminates an unnecessary twist of the jejunal loop

In performing a posterior gastro-enterostomy, the distal end of the loop of the jejunum is attached to a point of the stomach on the greater curvature, and the proximal end of the loop is attached on the posterior wall of the stomach closer to the lesser curvature The exact course of the jejunal loop differs somewhat depending on which method is employed However, we wish to state that in the most commonly used methods, such as Mayo's or Moynihan's, the loop does not lie either in the iso- or in the antiperistaltic direction in relation to the stomach

WHICH INSTRUMENTS SHOULD BE USED FOR DIVIDING THE TISSUES A KNIFE SCISSORS OR THE THERMOCAUTERY?

As long ago as 1900, Georg Kelling proved experimentally that the incisions made by a knife afford the fastest healing, next were those made by scissors, and that the slowest healing follows incisions made by the thermocautery Since that time these results have been corroborated by many other investigators

WHAT SUTURE MATERIAL SHOULD BE USED FOR GASTRO ENTEROSTOMY?

There are no unanimous views on this subject Some surgeons use a soluble material only, such as plain or chromic catgut, for all the layers of the stomach and bowel Others use only insoluble material, such as silk or the Pagenstecher celloidin linen thread In our work, we use the Pagenstecher linen for suturing the serous or seromuscular layers, and plain or chromic catgut for suturing the mucosa or the entire thickness of the stomach or intestinal wall.

IN HOW MANY LAYERS SHOULD THE STOMACH BE SUTURED TO THE BOWEL?

The oldest method consisted in sewing the lips of the stomach opening and that of the jejunum by an over-and over suture which was not reinforced by any other layer of sutures However, very soon this method was replaced by suturing in two tiers, the first, an over and over and the second, a seromuscular suture

This method has stood the test of time and should be considered as a good method of suturing

However, in recent years some experimentators have shown that the firmest union chiefly depends on a strict approximation of similar layers (serosa to serosa, muscularis to muscularis, and mucosa to mucosa)

For this reason we believe it is better in cases of gastro-enterostomy to use three layers in preference to two layers, since in all cases in which suturing of the stomach is involved exact approximation of the mucosa is of paramount importance.

We will describe in detail the technic of posterior gastro-enterostomy with a short or "no-loop" (Von Hacker-Petersen-Mayo method) and of anterior gastro-enterostomy with an entero-anastomosis (Wölfler-Braun method).

The other methods will not be described in detail. Those who are familiar with these two methods will have no difficulty in acquiring the technic of the other methods.

I. POSTERIOR GASTRO-ENTEROSTOMY (VON HACKER-PETERSEN-MAYO METHOD)

Step 1. The abdomen is opened by:

a. A paramedian left rectus incision, or

b. A transverse left transrectus incision.

Step 2. The transverse colon with the omentum are grasped with the left hand and drawn upward. This brings the transverse colon outside of the abdominal cavity and places the transverse mesocolon on the stretch. The first loop of the jejunum in then located in the manner described in Chapter III under the "Wölfler-Socin method" (Fig. 199). A segment of the jejunum, the length of which is four inches and which starts three or four inches away from the duodeno-jejunal junction, is grasped (Fig. 200). The contents of this segment are "milked out" and the loop is compressed axially by an intestinal clamp, tight enough to prevent the escape of intestinal contents when the bowel is opened, but not tight enough to shut off the blood-supply to that part of the bowel which forms the fold (Fig. 201). The clamp is placed so that the blades are directed to the left shoulder and the handles to the right hip-joint.

Step 3. An opening is made in the transverse mesocolon, the direction of which is perpendicular to the long axis of the transverse colon. This incision is made to the left of the main stem of the middle colic artery in the space which is rather poor in blood-supply and which is surrounded by the left branch of the middle colic artery and by the ascending branch of the left colic artery ("arteria magna Riolani") (Fig. 201). This "avascular area" is most suitable for the incision in the mesocolon. The incision is made in the following manner: A portion of the mesocolon in the "avascular area" is grasped by an Allis forceps, and half an inch away from the first forceps another Allis forceps grasps the transverse mesocolon, which is cut between the two forceps by scissors. The incision is continued upward by the scissors and downward by the knife. [Care should be taken not to cut the "arteria magna Riolani" when cutting the mesocolon up-

ward and not to reach the base of the transverse mesocolon when cutting downward, in order to avoid injuring the branches of the superior mesenteric artery.]

Step 4. The tip of the little finger of the surgeon's left hand is placed on the anterior wall of the stomach on a vertical line drawn downward

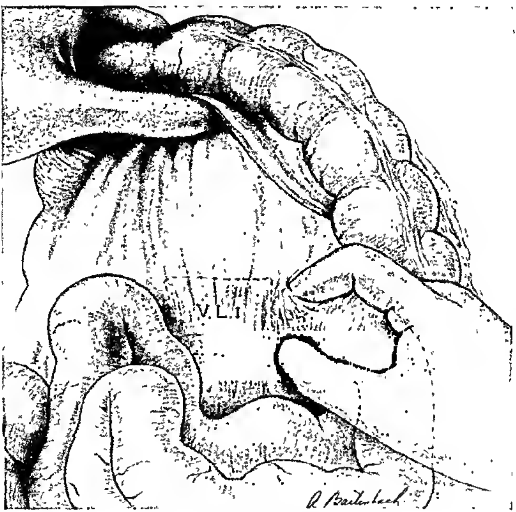

FIG. 199. Posterior gastro-enterostomy. Location of the first jejunal loop by the Wölfler-Socin method.

from the right side of the cardia to the greater curvature at a distance of about one and one-half inches above this curvature. The tips of the rest of the bent fingers of the surgeon's left hand are placed on the anterior wall of the stomach in such a manner that the index-finger will rest on the greater curvature and will be approximately two and a half inches to the left from the vertical line extending from the right side of the cardia

downward (Fig. 202). With the bent fingers of the left hand the stomach is pushed downward through the opening in the transverse mesocolon. In this manner the posterior wall of the stomach is protruded into the general peritoneal cavity, and is grasped by two Allis forceps at two points, one corresponding to the point on the posterior wall which is pushed by the

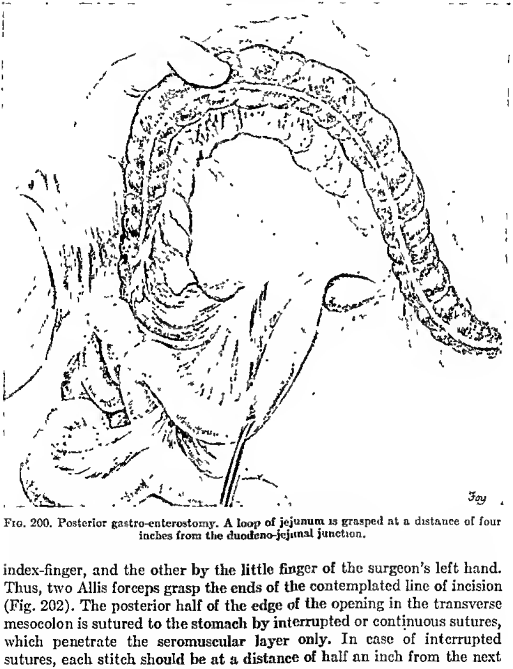

FIG. 200. Posterior gastro-enterostomy. A loop of jejunum is grasped at a distance of four inches from the duodeno-jejunal junction.

index-finger, and the other by the little finger of the surgeon's left hand. Thus, two Allis forceps grasp the ends of the contemplated line of incision (Fig. 202). The posterior half of the edge of the opening in the transverse mesocolon is sutured to the stomach by interrupted or continuous sutures, which penetrate the seromuscular layer only. In case of interrupted sutures, each stitch should be at a distance of half an inch from the next

one. Approximately six or seven sutures will be inserted (*Fig. 203*). [It is more convenient to do this suturing of the posterior part of the mesocolon to the stomach at this stage of the operation than after the gastro-enterostomy is completed. This was first suggested by L. L. McArthur.] A stomach-clamp is now placed on the stomach-fold in such a manner that the

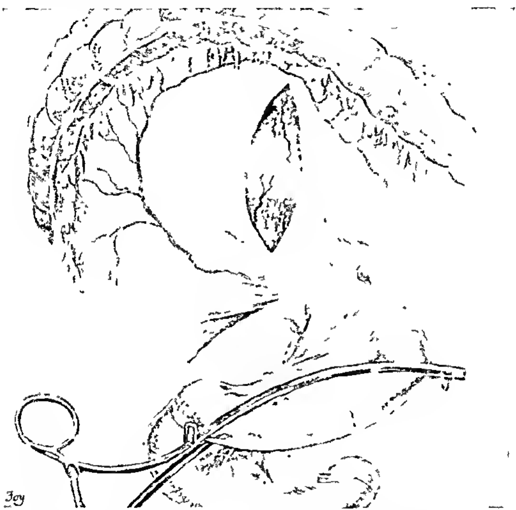

FIG. 201. Posterior gastro-enterostomy. A loop of the jejunum is clamped axially, a slit is made in the transverse mesocolon

tips of the blades will be directed toward the right hip-joint and the handles toward the left shoulder-joint (Fig. 204). Then the clamp holding the jejunal fold is turned in such a manner that the handles are directed toward the left shoulder-joint and the blades toward the right hip-joint. Thus, the stomach and the jejunal clamps are laid side-by-side. The handles of both clamps are directed now to the left shoulder-joint and the tips of

the blades to the right hip-joint (Fig. 204). [As may be seen, the handles will lie on the assistant's side and the blades on the surgeon's side. This is an important technical point, since the assistant holds the clamps and it is more convenient for him to hold its handles on his side than to lean over the body of the patient and hold it on the surgeon's side.] Another point

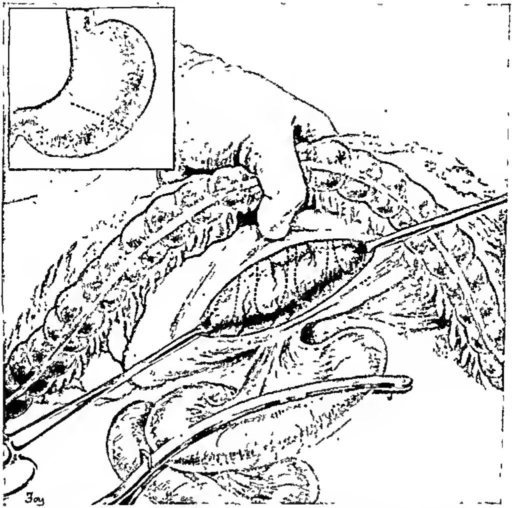

FIG. 202. Posterior gastro-enterostomy. The posterior wall of the stomach protrudes into the greater peritoneal cavity.

worthy of notice is that the highest point of the stomach-incision is sutured to the proximal end of the jejunum, and the lowermost point of this incision is sutured to the distal end of the jejunum. Also note that the direction of the incision on the stomach will exactly tally with the normal position of the first loop of the jejunum. The majority of surgeons interpret this mutual position of the stomach and jejunum as anti-

peristaltic. We believe, however, that it is neither anti- nor iso-peristaltic, since the incision on the stomach is made perpendicularly to the direction of its peristaltic waves.

Step 5. The adjoining blades are attached to each other by an artery-clamp, grasping the rubber tubing which covers the blades Laparotomy

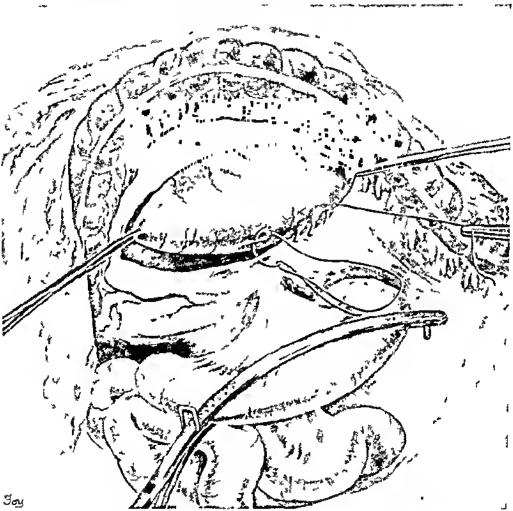

Fig 203 Posterior gastro-enterostomy Suturing the posterior wall of the stomach to the posterior lip of the transverse mesocolon

sponges are laid around the clamps so as to "wall off" the operative field from the rest of the peritoneal cavity. In this manner the instruments are covered with laparotomy sponges and only two folds, that of the stomach and of the jejunum, are left exposed. [In our work we use the Lane clamp, which is shown on the pictures]

Step 6. A continuous sero-serous suture with a straight needle is

made between the folds of the stomach and the jejunum (Dupuytren or Cushing type). It starts from the assistant's and runs to the surgeon's side (Fig. 205, upper half). The short end of the thread is clamped by a straight artery-forceps of the Kocher type and is placed under a towel [no instruments should be left uncovered]. If the Dupuytren type of suture

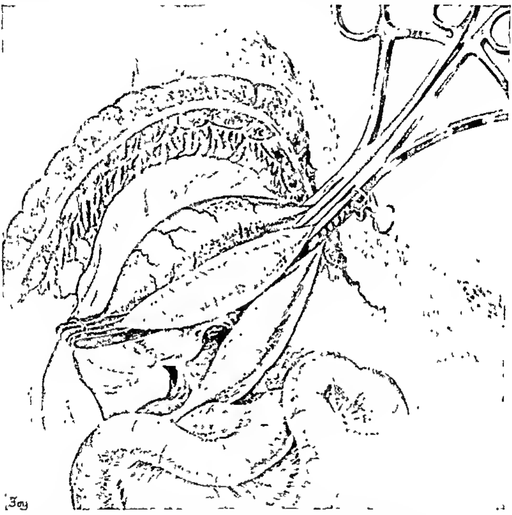

FIG. 204. Posterior gastro-enterostomy. The folds of the stomach and of the jejunum are laid side by side. The tips of the blades are directed to the right hip-joint.

is selected, the direction of the needle should always be from the surgeon's right to his left hand. Each third stitch is locked, or, still better, a back-stitch is made after each three ordinary stitches. As soon as the sero-serous suture-line is completed for the length of about three inches, the last stitch is then locked, or a last back-stitch is made, and the straight needle is then inserted into a piece of gauze (so that it will not be lost)

and is placed with the gauze under a towel on the surgeon's side By adopting this technic, no instruments, needles or threads are left exposed Everything except the two folds of the viscera are covered with towels It is also worthy of note, that the beginning of the sero-serous suture is clamped with a straight forceps and the end of it is threaded on a straight needle

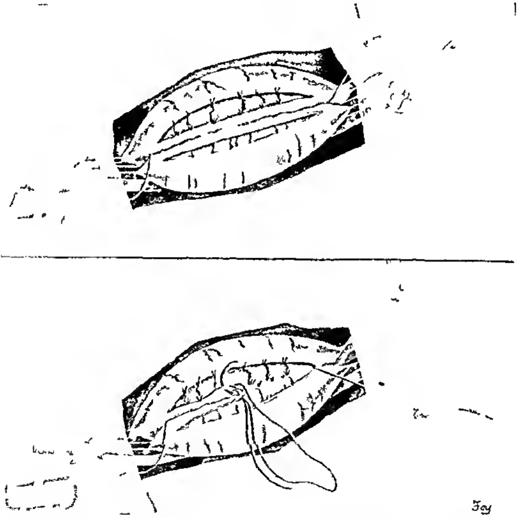

FIG 205 Posterior gastro-enterostomy *Upper half*—Sero-serous suture is inserted a seromuscular incision is made *Lower half*—Suturing the seromuscular lips to each other

Step 7 The seromuscular layers of the jejunum and stomach are now incised On the jejunum the incision should be at a distance of about one eighth of an inch and on the stomach, of about one fourth of an inch from the suture line (Fig 205 upper half) [The reason for making the seromuscular incision on the stomach farther from the suture line than on the jejunum is that the seromuscular layer of the stomach contracts

much more than does that of the jejunum.] The incision is made on the jejunum with the right hand and on the stomach with the left hand. In this way the surgeon does not have to change the position of his body. All the blood-vessels running in the mucosa are ligated at symmetrical points (Fig. 205, upper half). Thus, the occurrence of a post-operative hemor-

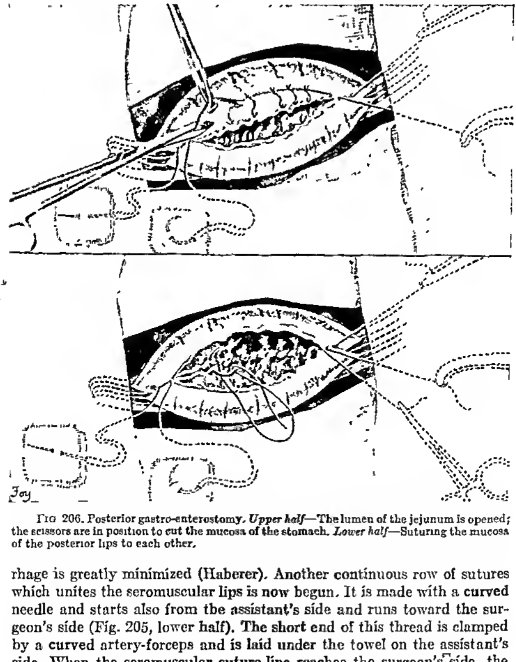

FIG 206. Posterior gastro-enterostomy. *Upper half*—The lumen of the jejunum is opened; the scissors are in position to cut the mucosa of the stomach. *Lower half*—Suturing the mucosa of the posterior lips to each other.

rhage is greatly minimized (Haberer). Another continuous row of sutures which unites the seromuscular lips is now begun. It is made with a curved needle and starts also from the assistant's side and runs toward the surgeon's side (Fig. 205, lower half). The short end of this thread is clamped by a curved artery-forceps and is laid under the towel on the assistant's side. When the seromuscular suture-line reaches the surgeon's side, the

last stitch is locked (and, of course, each third stitch should be locked while making this seromuscular suture-line or, still better, a back-stitch should be made after each three ordinary stitches). The needle is then inserted on a piece of gauze and is laid under a towel on the surgeon's side (Fig. 206, upper half). Thus, we will have so far, the straight artery-forceps lying on

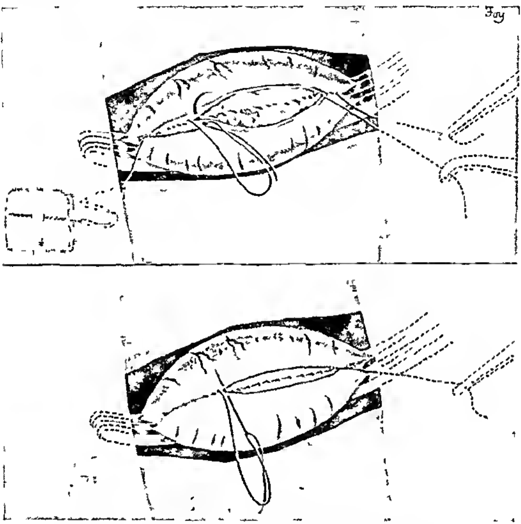

FIG 207. Posterior gastro-enterostomy. *Upper half*—The mucosa is sutured, suturing of the muscular lips begun. *Lower half*—Suturing of the serosa

the assistant's side attached to the thread which made the sero-serous suture, and the curved artery-forceps, lying on the assistant's side, attached to the thread which made the seromuscular-seromuscular suture.

Step 8. The mucosa on the jejunum is opened by a knife, held in the right hand, slightly lateral to the line of the previously made seromuscular incision, because the mucous lip should be slightly wider than the sero-

muscular lip. On the stomach, it is not advisable to cut with the knife, since the mucosa is very tough and if the knife is not sharp as a razor (and that is usually the case) it slides between the seromuscular and the mucous layer and does not cut through the mucosa. The mucosa of the stomach is opened in the following manner: It is grasped by an Allis forceps and

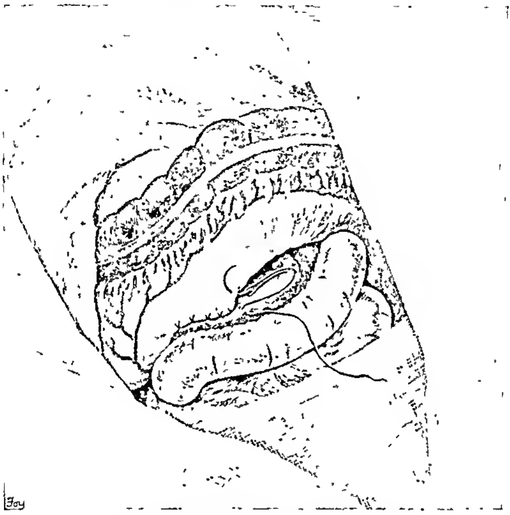

FIG. 208. Posterior gastro-enterostomy. Suturing the edge of the transverse mesocolon to the stomach-wall.

drawn up so that a cone is formed which is snipped with scissors (Fig. 206, upper half). The lumen of the stomach is thus opened. The mucosa is then cut by scissors, and care should be taken to make the mucous lip wider than the previously made seromuscular lip. The reason for this is that the mucosa has a great tendency to contract, and if cut on the same plane as the sero-muscular layer, it will contract to such an extent that it will

retract beyond the seromuscular lip, and in suturing the mucosa of the stomach to the mucosa of the jejunum the line of suture will be under a great tension The length of the incision in the mucosa should be slightly shorter than that of the seromuscular incision The suturing of the mucosa starts from the assistant s side (Fig 206, lower half) The thread is clamped by a mosquito artery forceps, which is placed under the towel Then an over and over mucosa mucosa suture is made, taking each bite one-eighth of an inch from the other Each third stitch is locked or a back stitch is made after each three ordinary stitches When the suture line is completed in its entire circumference the thread on the needle is tied to the beginning of the same thread which was clamped by the mosquito-forceps on the assistant s side and the ends are cut short The curved needle on the surgeon's side is then grasped and suturing of the anterior seromuscular lip is continued until it is entirely sutured anteriorly (Fig 207, upper half) Then it is tied to the short end of the thread which was clamped with a curved clamp on the assistant s side and the ends are cut short The straight needle on the surgeon s side is then taken and the serosa serosa suture of the anterior lip is continued until the assistant's side is reached (Fig 207, lower half) The threaded needle is then tied to the short end of the assistant's side and the ends are cut short [The clamps are removed from the bowel and the stomach fold either after completion of the mucosa mucosa suturing or after the serosa is sutured to the serosa]

Step 9 The edges of the anterior half of the transverse mesocolon are sutured to the stomach by a continuous suture or by several interrupted sutures which penetrate the seromuscular layer of the stomach only (Fig 208) If interrupted sutures are used they lie at a distance of half an inch from each other and at about one fourth of an inch away from the suture line Six to seven such sutures are usually required on the anterior half of the transverse mesocolon

When the stomach drops back after completion of the operation the *anastomosed loop of the jejunum will acquire its original position that is,* the position which it held before the gastro enterostomy was performed

II ANTERIOR GASTRO ENTEROSTOMY WITH ENTERO ANASTOMOSIS (WÖLFLER BRAUN METHOD) (FIG 209)

Step 1 The abdomen is opened in the same manner as Step 1 of "Posterior Gastro enterostomy"

Step 2 The first loop of the jejunum is located according to the Wolfler Socin method, and is grasped at a distance of 16 to 24 inches away from the duodeno jejunal junction Its contents are "milked out," and a fold four inches long is clamped axially by an intestional clamp, strong enough to prevent the escape of the intestinal contents when the bowel is opened, but not enough to shut off the blood supply to that part of the

bowel which constitutes the fold. The clamp is applied in such a manner that the handles lie to the left of the patient, that is on the assistant's side.

Step 3. A fold of the anterior wall of the stomach, the length of which is four inches, is grasped by a stomach-clamp very close to and parallel

FIG. 209. Anterior gastro-enterostomy with entero-anastomosis. Wölfler-Braun method.

with its greater curvature. This fold should be on the body of the stomach, not on the antrum. This clamp also is placed in such a manner that the handles lie to the left of the patient, that is on the assistant's side.

Step 4. Both clamps are laid side-by-side in such a manner that the handles lie on the assistant's side and the tips of the blades on the surgeon's side. [This is an important technical point, since it is more convenient for

the assistant to hold the handles lying on his side than to lean over the body of the patient and hold them on the surgeon's side] As may be seen in this method of placing the clamps, the stomach and the loop of the jejunum lie in an iso-peristaltic direction (Wolfler-Lucke-Rockwitz method)

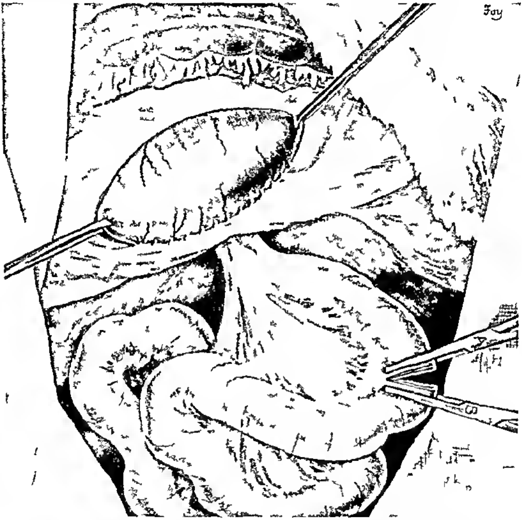

Fig 210 Posterior gastro-enterostomy (Socin Moose method) The jejunum is cut transversely between two clamps for two-thirds of its circumference

Step 5 As Step 5 in Posterior Gastro enterostomy

Step 6 As Step 6 in Posterior Gastro-enterostomy ' (Fig 205)

Step 7 As Step 7 in "Posterior Gastro-enterostomy" (Fig 206)

Step 8 As Step 8 in "Posterior Gastro enterostomy" (Fig 207)

Step 9 Two folds of the jejunum are grasped each starting four inches *away from the gastro-jejunal stoma, and one of which is on the afferent*

and the other on the efferent loop. The length of each fold is four inches. The contents of the loops are "milked out," and each fold is then clamped by an intestinal clamp. A lateral intestinal anastomosis connecting these two folds is made precisely in the same manner as described in the Chapter "Lateral Intestinal Anastomosis."

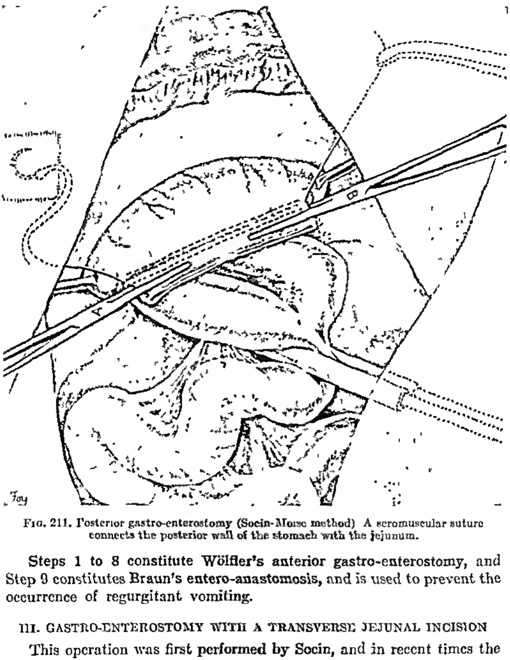

FIG. 211. Posterior gastro-enterostomy (Socin-Moise method) A seromuscular suture connects the posterior wall of the stomach with the jejunum.

Steps 1 to 8 constitute Wölfler's anterior gastro-enterostomy, and Step 9 constitutes Braun's entero-anastomosis, and is used to prevent the occurrence of regurgitant vomiting.

III. GASTRO-ENTEROSTOMY WITH A TRANSVERSE JEJUNAL INCISION

This operation was first performed by Socin, and in recent times the

interest in it has been revived by Moise, who elaborated the technic of its performance

Step 1 The abdomen is opened

Step 2 The first loop of the jejunum is located by the Wolfler Socin method At a distance of 4 to 5 inches from the duodeno jejunal junction two crushing clamps are placed on the jejunum perpendicularly to its long axis and embracing only two thirds of its circumference The clamps lie very close to each other (Fig 210) The bowel is cut between the clamps Thus, but two-thirds of the circumference of the bowel are divided The clamps are laid away from each other in opposite directions (Fig 211)

Step 3 An opening in the transverse mesocolon is made precisely as in Step 3 of ' Posterior gastro enterostomy

Step 4 The posterior wall of the stomach is pushed down through the opening in the transverse mesocolon and a fold of it is grasped by an Allis forceps at each end The posterior lip of the transverse mesocolon is sutured to the gastric fold

Step 5 A seromuscular suture is made between the stomach and the bowel (Fig 211)

Step 6 An intestinal clamp is placed on the two limbs of the bowel at a distance of about six inches below the open portion of the bowel (Fig 211) The crushed part of the wall of the bowel is cut off by making an incision beneath the blades of the two crushing clamps (Fig 211)

Step 7 An opening is made through the entire thickness of the stomach wall The anastomosis is completed in the usual manner (Fig 212)

Step 8 The edges of the slit in the mesocolon are sutured to the stomach as described in Step 9 of posterior gastro jejunostomy

IV SCHIASSI METHOD OF GASTRO ENTEROSTOMY WITH SECTION OF THE VAGI AND SYMPATHETIC NERVES

This operation consists of the following steps

a Division of the terminal branches of the right and left vagi nerves of the stomach

b Division of the sympathetic fibers which take their origin from the celiac plexus

c Performance of a posterior gastro-enterostomy

The reason for performing a and b is to prevent the transmission of any psychic irritations to the duodenum after the gastro enterostomy has been performed This operation is indicated for the surgical treatment of gastric and duodenal ulcer, particularly the latter

Step 1 The abdomen is opened

Step 2 The gastro hepatic ligament is divided for a length of two inches along a line which runs parallel to and one third of an inch above

the margin of the lesser curvature (Fig. 213). The vertical portion of the pyloric artery serves as a landmark for this incision, since the gastro-hepatic ligament is cut one inch to the left and one inch to the right of the artery, which is in the meantime ligated. [N.B. This incision cuts the six sympathetic filaments which run from the celiac sympathetic plexus to the

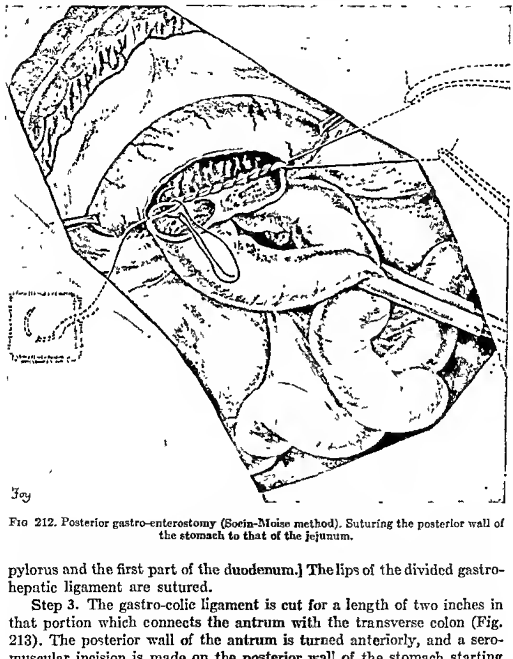

FIG 212. Posterior gastro-enterostomy (Socin-Moise method). Suturing the posterior wall of the stomach to that of the jejunum.

pylorus and the first part of the duodenum.] The lips of the divided gastro-hepatic ligament are sutured.

Step 3. The gastro-colic ligament is cut for a length of two inches in that portion which connects the antrum with the transverse colon (Fig. 213). The posterior wall of the antrum is turned anteriorly, and a sero-muscular incision is made on the posterior wall of the stomach starting

at the angular notch above and reaching the great curvature below The incised seromuscular layer is sutured by several interrupted sutures or by a continuous suture (Fig 214)

Step 4 The stomach is returned to its original position and the opening in the gastro colic ligament is closed by a few interrupted sutures

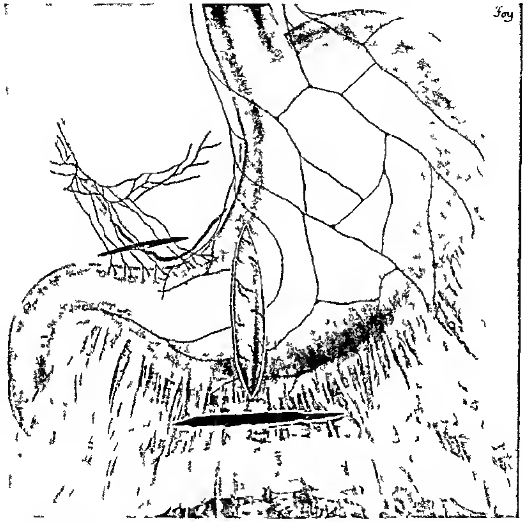

Fig 213 Posterior gastro-enterostomy Supplemented by section of the vagi and sympathici (Schiassi method) (Schiassi Annals of Surgery Vol 81) (See text)

Step 5 A seromuscular vertical incision is made on the anterior gastric wall extending from the angular notch of the lesser curvature to the great curvature and corresponding to the vertical incision on the posterior wall (Fig 213) The lips of the seromuscular incision are sutured by a few interrupted sutures or by a continuous suture (Fig 215) These two vertical incisions cut the branches of the right and left vagus nerves

Step 6. A posterior gastro-enterostomy is now performed. The final view will be as in Fig. 215.

V. DEGASTRO-ENTEROSTOMY

This consists in undoing a previously made gastro-enterostomy opening.

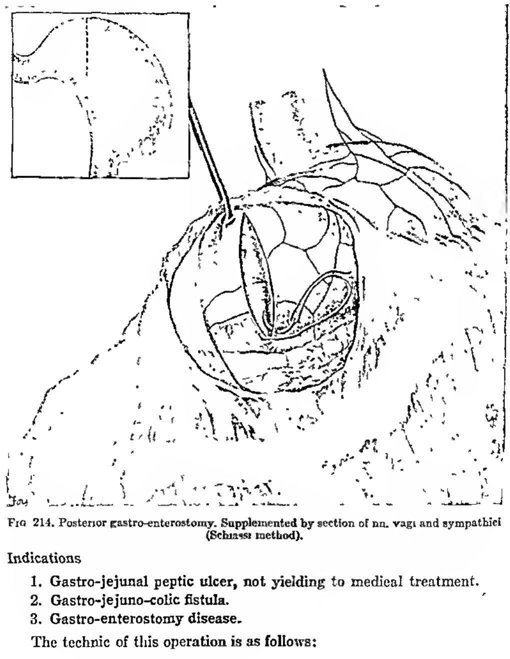

FIG 214. Posterior gastro-enterostomy. Supplemented by section of nn. vagi and sympathici (Schiassi method).

Indications

1. Gastro-jejunal peptic ulcer, not yielding to medical treatment.
2. Gastro-jejuno-colic fistula.
3. Gastro-enterostomy disease.

The technic of this operation is as follows:

Step 1. The omentum with the transverse colon are lifted with the left hand, thus putting the transverse mesocolon on the stretch.

Step 2. The mesocolon is cut at any convenient place at a distance of about one-fourth of an inch from the suture-line between it and the stomach. [Care should be taken not to cut large branches of the middle

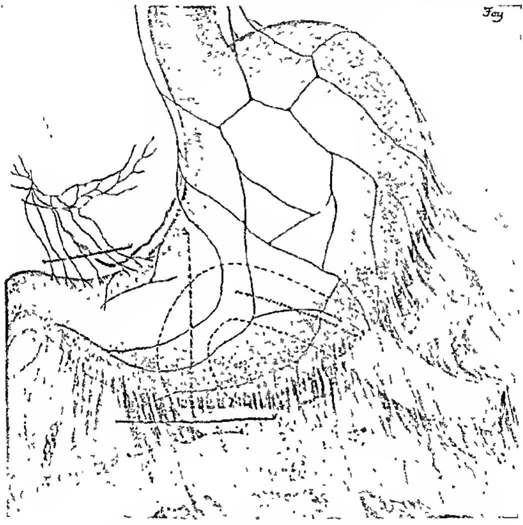

Fig. 215. Posterior gastro-enterostomy. Supplemented by section of nn. vagi and sympathici (Schiassi method).

colic artery.] The left index-finger is then introduced into the opening thus made, and under its guidance the mesocolon is gently separated from the stomach for its entire circumference (Fig. 216).

Step 3. The jejunal loop is caught and pulled down. This brings further down a portion of the posterior wall of the stomach. The contents of each jejunal loop adjoining the stoma are "milked out," and an intestinal

clamp is placed transversely on each of these jejunal loops, on the proximal, just a little away from the duodeno-jejunal junction, and on the distal, about five inches away from the stoma (Fig. 217). Two Kocher or Ochsner clamps are then placed on the jejunum, one on each loop in such a manner that the tips of the blades look downward and inward. The tips should

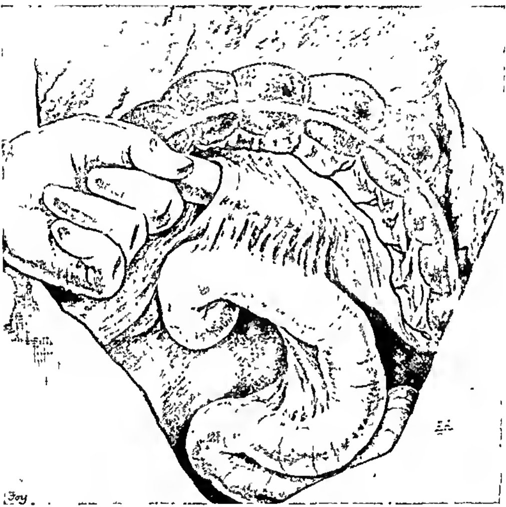

Fig. 216. Degastro-enterostomy. Separation of the mesocolon from the stomach by the index-finger.

meet each other, and each tip should reach a point midway between the mesenteric and the free border of the jejunal loop which is attached to the stomach (Fig. 217).

Step 4. The jejunum is cut immediately distal to each clamp (Fig. 218). In this manner, the opening connecting the stomach with the jejunum is closed by the clamps, thus preventing the escape of the stomach-

contents The jejunal opening is now closed in a transverse direction (Fig 219)

Step 5 The ulcerated portion of the stomach is excised and this opening is then closed (Fig 219)

Step 6 The opening in the mesocolon is closed

FIG 217 Degastro-enterostomy Two crushing clamps are placed on the jejunum the proximal and distal jejunal loops are clamped by two intestinal clamps

VI REDUCTION OF A RETROGRADE INVAGINATION OF THE *JEJUNUM INTO THE STOMACH*

Step 1 The abdomen is opened

Step 2 The jejunum is pulled downward until the reduction is complete If, however, the invagination is not corrected by this maneuver, then

Step 3. An incision in the anterior wall of the stomach is made, and the left index-finger is introduced into its lumen. The invaginated portion of the bowel is pushed downward by the finger of the left hand and with the right hand the jejunum is pulled downward until the reduction is accomplished.

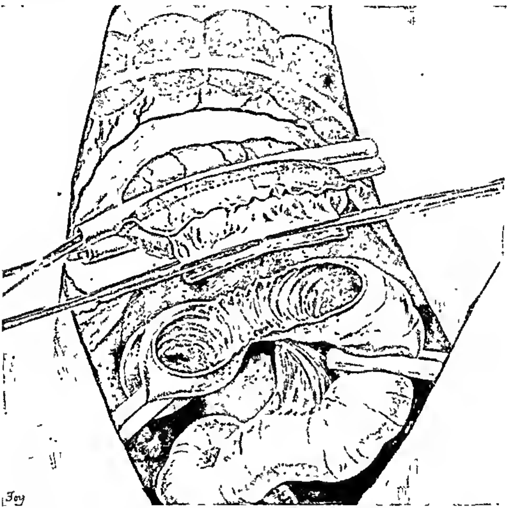

Fig. 218. Degastro-enterostomy. The opening into the stomach is closed by two crushing clamps thus preventing escape of the stomach-contents.

Step 4. The opening in the anterior wall of the stomach is closed.

Hardly any supplementary procedures are required for preventing a future occurrence of invagination, since records from the literature show that only once has re-invagination taken place.

ASEPTIC METHODS OF GASTRO-ENTEROSTOMY

All that has been said about the different "aseptic methods" of intes-

tinal anastomosis in Chapter VII may be repeated here For this reason, we refer the reader to the historical part of Chapter VII However, we would like to emphasize here only a few points

1 "The ideal aseptic methods," such as Postnikow's, Bastianelli's and Boari's, should never be used either in intestinal or in gastro-intestinal

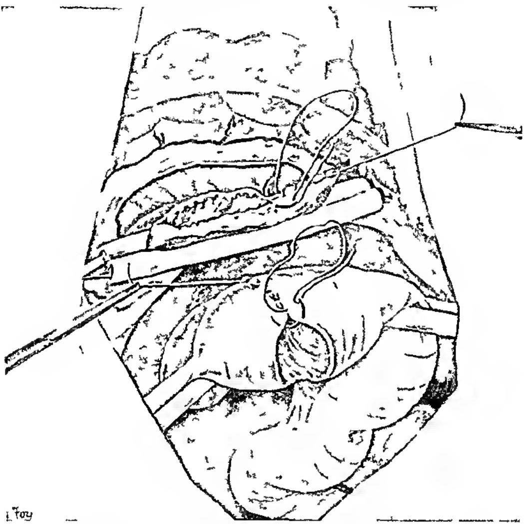

FIG 219 Degastro-enterostomy Closure of the jejunal and gastric openings

anastomosis on account of possible complications, such as failure of making an opening either in the stomach or in the jejunum or in both

2 The "relatively aseptic methods," such as are performed by using "basting suture methods" or "closed clamps methods," are excellent for intestinal suturing only, particularly when the large bowel is involved in the suturing, but should never be used in stomach work, since in these methods the mucosa of the stomach is not sutured to the mucosa of the

bowel, and this may readily produce a postoperative jejunal ulcer. This, as a rule, is worse than the original gastric or duodenal ulcer for the relief of which the original operation was performed. For this reason, we may say that "aseptic methods" are contraindicated in all surgery in which suturing of the stomach is involved.

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CHAPTER XVIII

GASTRO-DUODENOSTOMY

Definition.

This is the establishment of an artificial communication between the lumen of the stomach and that of the duodenum

Historical

This operation was first performed on a human being by Péan, in 1879, Rydygier, in 1880, and Billroth, in 1881, as one of the steps of pylorectomy

Kocher, in 1890, while performing a partial gastrectomy, implanted the severed duodenum into the anterior wall of the remaining portion of the stomach and in the following two cases of gastrectomy implanted it into the posterior wall of the stomach He coined the expression "gastro-duodenostomy"

Jaboulay, in 1892, conceived the idea of making a gastro duodenostomy as an operation per se and not as a mere step in gastrectomy He suggested that this operation be used instead of gastro jejunostomy in all cases of pyloric stricture or obstruction, in which pyloroplasty is contra-indicated He considered it a more physiological procedure than gastro jejunostomy and free of such complications as regurgitant vomiting ("vicious circle") He advised suturing the anterior wall of the stomach to the second (descending) portion of the duodenum (Fig 220, a) It was first performed by him on a human in 1894, and he is quite justly considered as the originator of this operation

Villard, on April 20, 1897, performed his first case of this type of gastro-duodenostomy and he coined the expression "subpyloric gastro-duodenostomy" (Gastro-duodenostomie sous-pylorique")

Julius Schnitzler, of Vienna, performed gastro-duodenostomy several times His first case was done on August 18th, 1899 His associate, E Klein, reported this first case of Schnitzler in 1900, and he coined for this type of gastro-duodenostomy the name "lateral gastro-duodenostomy"

However, neither Jaboulay nor Schnitzler mobilized the second portion of the duodenum, and the technic of the performance of this operation in the manner as employed by Jaboulay, Villard and Schnitzler was not easy

Henle, in 1898, reported a case of gastro-duodenostomy which was performed by Mikulicz according to the plan of Henle The stomach was united with the pars superior duodeni (Fig 220, d)

Kocher greatly facilitated the technic of gastro-duodenostomy by

mobilizing the second portion of the duodenum, which made its technic a simple procedure (Fig. 220, b). His article was published in January, 1903. His technic is that of the lateral gastro-duodenostomy of Schnitzler (Klein) or of the subpyloric gastro-duodenostomy of Jaboulay (Villard).

Finney, in July, 1902, published his method of gastro-duodenostomy

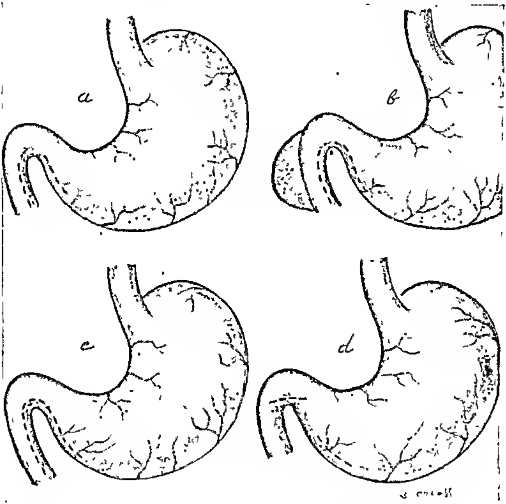

FIG. 220. Different types of gastro-duodenostomy. a. Jaboulay method; b. Kocher method; c. Finney method; d. Henle method.

(Fig. 220, c), which he quite correctly calls pyloroplasty, since in his method the incision is made not only through the stomach and the duodenum but also through the pyloric ring, whereas in the methods of Jaboulay, Henle and Kocher the pyloric ring is left intact.

All these methods, with the exception of the Finney method, are now very seldom used. For this reason, we shall describe here only two methods:

1. The Method of Kocher, (since it carries the very important feature of mobilization of the second part of the duodenum, which is of great importance in performing a partial gastrectomy by the Billroth I method).
2. The Method of Finney.

Indications.

The indications are the same as for a gastro-jejunostomy.

The *advantages* of a gastro-duodenostomy over a gastro-jejunostomy are:

1. Gastro-duodenostomy eliminates the occurrence of regurgitant vomiting.
2. No ulcers are formed at the site of the new stoma (nevertheless, this might occasionally occur).
3. The duodenum is retained as a part of the alimentary tract, whereas, in case a gastro-jejunostomy has been performed, the duodenum is transformed into an excretory duct carrying bile and pancreatic juice.

The *disadvantages* of gastro-duodenostomy are:

1. It is technically more difficult to perform.
2. In all methods of gastro-duodenostomy the stoma is not located on the most dependent portion of the stomach.

1. KOCHER'S GASTRO-DUODENOSTOMY

This operation is actually a lateral gastro-duodenostomy. The characteristic feature of it is the mobilization of the second portion of the duodenum.

Technic.

Step 1. The abdomen is opened by a longitudinal or transverse incision.

Step 2. The parietal peritoneum which covers the anterior surface of the hilum of the right kidney is cut longitudinally at a distance of about one and-a-half inches away from the right border of the second portion of the duodenum. This enables the surgeon to introduce the index-finger of his left hand behind the duodenum and lift it from the structures lying back of it (Fig. 221). However, it is not advisable to carry the separation to the left of the vena cava inferior. Not only the duodenum, but also the most lateral portion of the head of the pancreas is lifted. No blood-vessels are injured.

Step 3. A fold of the second portion of the duodenum is clamped axially by an intestinal clamp, and a fold of the anterior stomach-wall very close to the greater curvature is also clamped axially by an intestinal (or stomach) clamp. An anastomosis is made between these folds precisely as described in the lateral intestinal anastomosis [N.B. In his original description, Kocher does not mention the use of clamps.]

FIG. 221. Kocher method of mobilization of the duodenum.

2. THE METHOD OF FINNEY

This method was described in 1902.

Step 1. A suture is inserted into the upper end of the anterior surface of the pylorus (point A, Fig. 222, insert), another into the anterior wall of the stomach at the greater curvature and about five inches below the first suture (Fig. 222, insert, point B), and a third is passed through point C on the anterior wall of the second portion of the duodenum at a distance of five inches from the point A (point C, Fig. 222). These three sutures are used as traction-sutures. They should be of catgut and they penetrate the seromuscular layer only.

Step 2. The guy-suture A is drawn upward, the guy-sutures B and C, downward. The adjacent portions of the stomach and duodenum are then

laid side by-side A continuous seromuscular suture is inserted, connecting the adjacent portions of the stomach and duodenum (Fig 222)

Step 3 A number of interrupted seromuscular mattress sutures are inserted connecting the anterior wall of the stomach with that of the duodenum (Fig 222) The *distance between each two consecutive sutures*

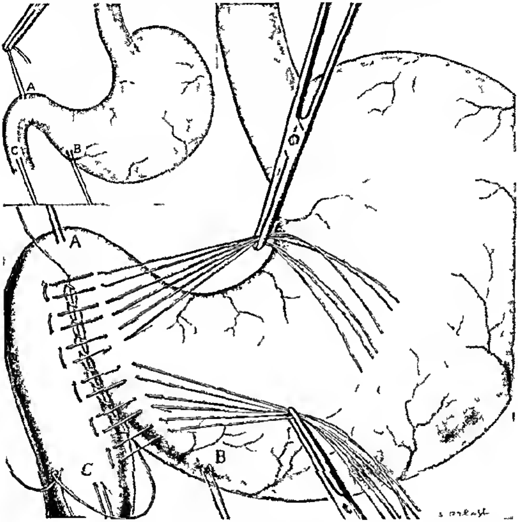

FIG 222 Finney gastro-duodenostomy *Insert*—Guy sutures inserted *Main picture*—Seromuscular continuous sutures inserted a series of mattress-sutures are made

is one fourth of an inch The bite of each mattress-suture on the duodenal side is inserted about one-fourth of an inch away from the seromuscular suture line, and on the stomach about one half of an inch away from the same line (Fig 222) The ends of each mattress suture are not tied now, but the free ends of the upper half of the series of sutures are grasped by one clamp and the free ends of the lower half of the series are grasped by another clamp

Step 4. At the point where the threads cross the seromuscular suture-line which connects the stomach with the duodenum, they are lifted by two hooks, the upper half by one hook which pulls them upward and the lower by another hook which pulls them downward (Fig. 223, a).

Step 5. A horse-shoe incision is made through the entire thickness of

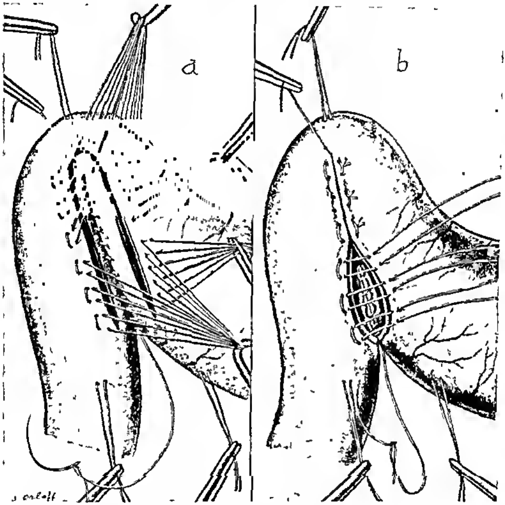

Fig. 223. Finney gastro-duodenostomy. a. Horse-shoe incision which penetrates the stomach and the duodenal walls. *b.* The *posterior lips are united by a continuous suture; the mattress-sutures are tied.*

the gastric and duodenal walls, the vertical limbs of which stop one-fourth of an inch above the lower end of the seromuscular suture-line. The incision is made on the duodenal side at a distance of about one-eighth of an inch, and on the stomach side at a distance of about one-fourth of an inch, from the seromuscular suture-line (Fig. 223, a). [The making of the

incision is technically simple on the stomach and on the duodenum However, *it is more difficult at the pyloric ring, since if we will apply the same* pressure in cutting the first part of the duodenum as in cutting the pylorus, one is liable to cut the posterior wall of the first part of the duodenum. In order to prevent this, it is best to cut first the anterior wall of the stomach up to the highest point and then to do the same on the duodenal side Then a tissue-forceps, the blades of which are directed to the pylorus, is inserted and the anterior wall of the pylorus is cut between the separated blades]

Step 6 The scar-tissue upon either side of the incision is excised The redundant edges of the mucous membrane of the stomach are cut away in order to prevent the formation of a valve-like fold of this membrane

Step 7. A continuous through-and through suture is inserted on the posterior lips of the incision (Fig 223, h)

Step 8. The ends of each mattress-suture are tied serially (Fig 223, b)

Step 9 A continuous seromuscular suture reinforces the anterior suture-line

3 THE GOULD MODIFICATION OF FINNEY'S GASTRO PYLORO DUODENOSTOMY

This modification differs from the original method of Finney in two points

1 The duodenum is mobilized according to the method of Kocher (Fig 221), and

2 Intestinal clamps are used both on the stomach and on the duodenum The operation is then performed precisely in the same manner as was described in "Lateral Intestinal Anastomosis"

The Gould modification is technically easier to perform than the original Finney gastro-duodenostomy However, there is only one drawback to this method, namely, that while applying an intestinal clamp on the duodenum the ampulla of Vater may be caught in the clamp and injured

Technic

Step 1. The duodenum is mobilized by Kocher method (Fig 221)

Step 2 Intestinal clamps grasp a fold on the duodenum and another on the stomach The fold on the duodenum is about three inches long and the clamp holding it lies in such a manner that the tip of the inner jaw rests against the lower border of the pyloric sphincter The other clamp is placed on the stomach in a similar manner, so that the tip of the inner jaw of the latter touches that of the duodenal clamp at the pylorus (Fig 224)

Step 3. The clamps are laid side-by-side, and a row of seromuscular sutures, three inches long, is inserted beginning at the pyloric angle (Fig 224, insert)

Step 4. A horse-shoe incision is made in the same manner as described in the Finney gastro-pyloro-duodenostomy (Fig. 224, insert).

Step 5. A through-and-through suture is inserted in the posterior lips starting at the pyloric angle. These posterior lips form the posterior wall of

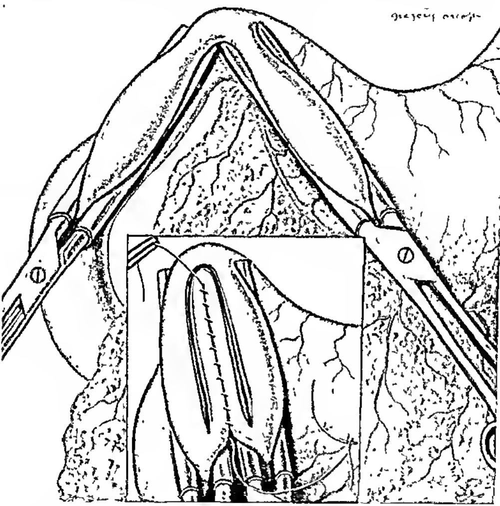

FIG. 224. Gould method of gastro-duodenostomy. *Main picture*—Clamping a fold of the stomach and of the duodenum. *Insert*—The folds of the stomach and the duodenum laid side by side; a seromuscular suture is inserted.

the newly formed stoma. The suture is continued over the lateral lips which form the anterior wall of the newly formed stoma. This anterior suture-line is reinforced by a seromuscular suture which is made with the same thread that was used for making the seromuscular suture on the posterior lip.

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CHAPTER XIX

GASTRECTOMY

Definition.

The term gastrectomy consists of two Greek words γαστήρ, stomach and ἐκτομη, removal. It means removal of the stomach.

Nomenclature.

There is some confusion in terminology. Some use different terms for the very same procedure. The names most commonly used are:

1. **Sphincterectomy,** when only the pyloric sphincter is removed (Fig. 225).

2. **Pylorectomy,** when the pylorus is removed (Fig. 225).

3. **Partial gastrectomy,** when the pylorus and part of the body of the stomach is removed up to the Hartmann or to the Mikulicz line (Fig. 225).

4. **Subtotal gastrectomy,** when the pylorus and the greater part of the body are removed up to the Mayo line (Fig. 225).

5. **Total gastrectomy,** when the entire stomach is removed, leaving on the proximal end the cardia and on the distal end the first portion of the duodenum (Fig. 225).

6. **Annular gastrectomy** (or "sleeve resection"), when the middle portion of the body of the stomach is removed (Fig. 225, insert).

7. **Fundusectomy,** when the fundus is removed (Fig. 235).

Indications.

1. **Carcinoma of the stomach.**—This is an absolute indication, provided that the case is operable in the mechanical sense.

2. **Large callous ulcers of the stomach.**—The majority of surgeons consider this as an indication for gastrectomy. However, there are surgeons who employ some other operation for callous gastric ulcer, such as mere excision of the ulcer, or excision with a gastro-enterostomy, or a mere jejunostomy.

3. **Duodenal ulcer.**—Many surgeons are performing gastrectomy for the treatment of duodenal ulcer.

METHODS EMPLOYED

The great number of different methods described can be classified into two groups:

1. **Billroth I.**—This method is characterized by the removal of a portion of the stomach and by reëstablishment of the continuity of the gastro-

intestinal tract by suturing the remaining portion of the stomach to the duodenum (Fig 226)

2 Billroth II —This method is characterized by the removal of a portion of the stomach and by reëstablishment of the continuity of the gastro-intestinal tract by suturing the stomach to the jejunum (Fig 227)

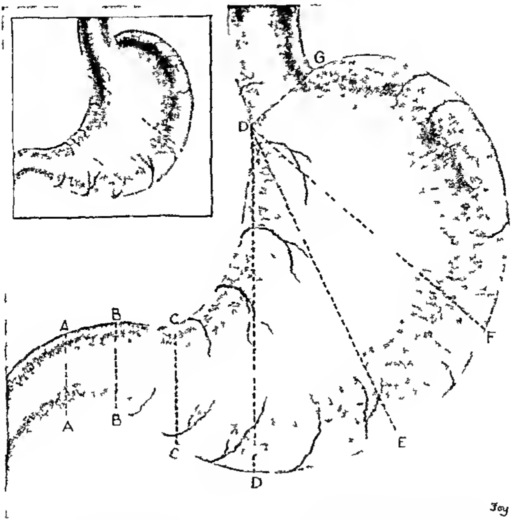

Fig 225 Gastrectomy Sphincterectomy Removal of the portion of the stomach between the lines AA and BB *Pylorectomy* Removal of the portion of the stomach between AA and CC *Partial gastrectomy* Removal of the portion of the stomach between AA and DD (Hartmann line) or DE (Mikulicz line) *Subtotal gastrectomy* Removal of a portion of the stomach up to DF (Mayo line) *Total gastrectomy* Removal of the entire stomach between AA and DG *Sleeve resection* See insert

There are described a few modifications of the Billroth I operation, and numerous modifications of the Billroth II

BILLROTH I AND ITS MODIFICATIONS

Billroth I —This operation consists of a resection of a portion of the

stomach, plus blind closure of the upper portion of the stomach-stump, plus end-to-end gastro-duodenostomy (Fig. 226, a, b, c).

Its Modifications.

1. Kocher's side-to-end gastro-duodenostomy.—This consists in a resection of a portion of the stomach, plus blind closure of the stomach-

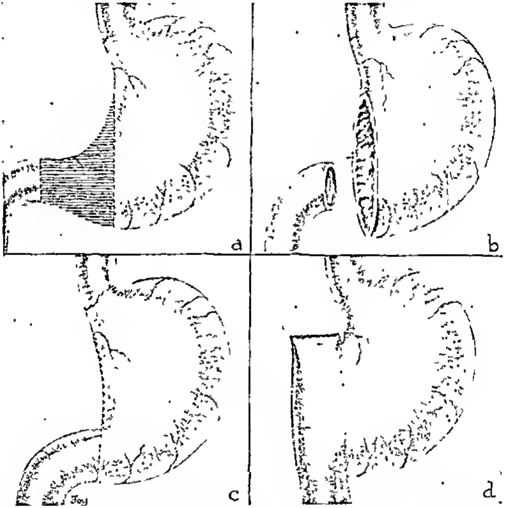

Fig. 226. Billroth I and its Modifications. a. The portion of the stomach between the dotted lines is to be removed; b. This portion of the stomach is removed; c Final view of Billroth I; d. Kocher (Haberer-Finney) modification of Billroth I.

stump, plus side-to-end gastro-duodenostomy, anterior or posterior. This method is obsolete.

2. Kocher's end-to-side gastro-duodenostomy.—This consists in a resection of a portion of the stomach, plus blind closure of the duodenal stump, plus implantation of the stomach-stump into the lateral wall of the

second part of the duodenum (Fig 226, d) This method was suggested by Kocher, in December, 1902, in the following words

"One can, if he employs such an operation [gastro-duodenostomy], come across those cases in which, after resection of the pylorus, it may be advisable to close blindly the severed duodenum, and perform a lateral gastro-duodenostomy between the stomach and the descending part of the duodenum " Von Haberer, in 1922, being unaware of Kocher s description, suggested this method as a new operation It is known in Europe as Haberer's modification of Billroth I Finney, in 1923, suggested this method again He refers to Haberer's work However, he does not mention Kocher's article, evidently having been unaware of it It is known in the United States as the Haberer-Finney modification of Billroth I

A far greater number of methods have been described at different times by different men for variations of the Billroth II method They did not know that the particular method had already been described, and claimed that they had discovered ' a new method " Numerous charges and counter charges were made by many for the right to claim the priority of one or another modification, and the most interesting part of the controversies is that many participated in these charges except the originators of the methods We will discuss this more in detail in the historical part of gastrectomy

Historical

The first thesis on the removal of a portion of the stomach was written by Daniel Paul Carl Theodore Merrem, of Giessen, in 1810 In this article he states that pylorectomy was first performed by an American surgeon of Philadelphia, who performed several pylorectomies on dogs and who, in spite of the fact that they all died, advised its use in suitable cases in human beings Finney believes that the surgeon referred to is John Jones, who was, before coming to Philadelphia, the first professor of Surgery in King s College of New York, afterwards the College of Physicians and Surgeons and later Columbia University Merrem performed three pylorectomies on dogs, of which two survived After removal of the pylorus he sutured the remaining portion of the stomach into the duodenum by the invagination method, which was at that time the method of reestablishing the continuity of the intestinal tract

Ruggero Torelli is probably the man to whom should belong the credit for being the first who resected a portion of the stomach in a human being It was, however, only a resection of the anterior stomach wall which was incarcerated in a fissure of the ventral hernia It was not a gastrectomy as we understand it now, in which the essential element of the operation is the removal not only of the portion of the anterior but also of the posterior wall including both curvatures He performed the operation on

September 14, 1865. After removal of a portion of the anterior gastric wall, he closed this opening in the stomach with sutures. The patient recovered. However, this was not a deliberately planned operation. It was carried out because of the force of circumstances. In 1876, Gussenhauer and Winiwarter reported seven cases of pylorectomy on dogs, of which two survived the operation. Kaiser, of the Czerny clinic, in 1876 and 1877, repeated the experiments of Gussenhauer and Winiwarter and reported the results in 1878. He made an annular resection of the stomach on five dogs. He was more fortunate than Gussenbauer and Winiwarter, since of the five dogs, four survived the operation. Czerny and Kaiser also performed five total gastrectomies, of which four dogs died and one survived. The latter was the famous "Czerny dog" which lived five years after the operation and later was killed and examined by the great physiologist Ludwig. In 1877, Billroth performed a gastrorrhaphy on a human, and in reporting the case he wrote, "Es ist von dieser Operation zur Resektion eines Stückes carcinomatos degenerirten Magens nur noch ein kühne Schritt zu machen." ("From this operation to resection of a piece of a carcinomatously degenerated stomach it is necessary only to make one bold step.") He, evidently, did not know that a portion of the stomach had already been resected twelve years previously to this statement by Ruggero Torelli. However, this in no way diminishes the great services of Billroth, who spoke of a deliberately planned removal of a portion of a carcinomatous stomach, thus introducing for the first time the surgical treatment of cancer of the stomach.

Péan, on April 9, 1879, performed the first pylorectomy on a human being. The operation lasted two and a half hours. The patient died on the fifth post-operative day. No autopsy was made because of refusal of the relatives. This type of pylorectomy (pylorectomy plus gastro-duodenostomy) is known in France as "Péan's operation." The next case of pylorectomy was performed by Rydygier on November 16, 1880. The operation lasted four hours and the patient died four hours after the operation.

On January 29, 1881, Billroth operated upon a woman, 43 years of age, for cancer of the stomach. The operation lasted one and a half hours. The patient recovered. This is the first case of a successfully performed pylorectomy on a human being. He reëstablished the continuity of the gastro-intestinal tract by suturing the remaining portion of the stomach to the duodenum. This type of operation is known as the Billroth I operation (Fig. 226).

After the first case, several other cases were reported by different surgeons, for the most part in Germany and Austria. At that time, they did not know how to mobilize the duodenum. For this reason, they could

not make an extensive gastric resection on account of the inability to suture the remaining portion of the stomach to the duodenum Extensive gastric resections became possible only after the Billroth II method had been developed It is interesting to note that this, the "Billroth II method," was not introduced for the purpose of overcoming the difficulties encountered in performing the Billroth I method Billroth had a case of a very weak patient, and he was afraid that the patient might not be able to stand an operation of such magnitude as gastrectomy in one stage Therefore, he decided to perform as a first stage the gastro-enterostomy, and a few days later, as the second stage, a pylorectomy After completing the anterior gastro jejunostomy, which was the usual type of gastro-enterostomy at that time, he found the patient to be in fairly good condition He, therefore, proceeded with the operation He removed a portion of the stomach between the duodenum and the site of the anastomosis and closed blindly both the duodenal and the stomach ends This operation was performed on January 15, 1885, and on February 20, 1885, Billroth reported the case at a meeting of the Royal Medical Society in Vienna In the very same year, Von Hacker reported this case, and describing the technic of Billroth, wrote, that the continuity of the gastro intestinal tract can be reestablished by suturing the lower part of the open end of the remaining portion of the stomach to a loop of jejunum Therefore, if credit should be given to any man for introducing a "Modification of the Billroth II Method," it should be given first of all to Von Hacker Kronlein, of Zurich, was the first man who actually carried out the suggestion of Von Hacker On November 24, 1887, he performed a partial gastrectomy, closed blindly the duodenum and reestablished the continuity of the gastro-intestinal trsct by making an end-to side gastro jejunostomy antecolica, using for anastomosis the entire length of the stomach stump As we may see, this operation differs from Polya's operation only in this respect, that Kronlein brought the jejunum in front of the colon, whereas in Polya's method this was placed retrocolically In order to avoid making a large stoma between the stomach and the jejunum Von Eiselsberg, in a case of gastrectomy performed on April 2, 1888, closed blindly the upper portion of the stomach stump and sutured the lower end of it to the jejunum, which also was brought ante colically This method was much later rediscovered, with the difference only that the jejunum was placed retrocolically, and this is known as the "Finsterer Hoffmeister's modification of Polya" (Fig 228, insert)

The first who placed a loop of the jejunum retrocolically for partial gastrectomy was Roux, who performed a gastrectomy in the following manner Partial gastrectomy, plus blind closure of the duodenal stump, plus blind closure of the stomach stump, plus gastro-jejunostomy retrocolica in a "Y" form The first who performed gastrectomy in the manner

which is now commonly known as the "typical Billroth II method" was Braun, who did it in 1894. His method differs from the original Billroth II method in this respect that whereas in the original Billroth II method the loop of the jejunum was placed antecolically, he placed it retrocolically. Therefore, his method is a "partial gastrectomy, plus blind

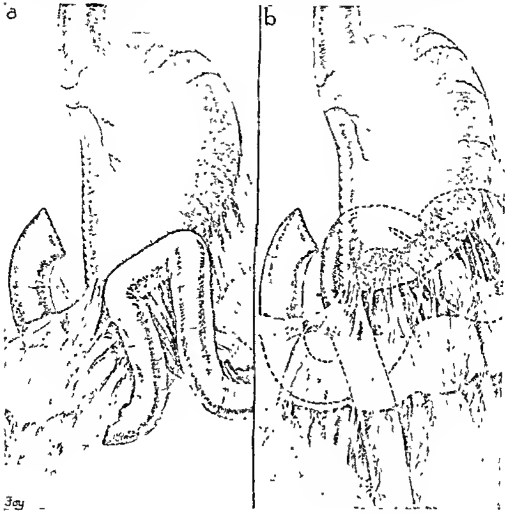

FIG. 227. a. "Original" Billroth II. b. Braun modification of Billroth II.

closure of the duodenal stump, plus closure of the stomach-stump, plus gastro-jejunostomy retrocolica posterior" (Fig. 227, b). Reichel, in 1908, published a method that he had been practicing since 1907, namely a partial gastrectomy, plus blind closure of the duodenal stump, plus end-to-side gastro-jejunostomy retrocolica (Fig. 228). As already mentioned, this method differs from the operation performed by Krönlein, in 1887, only in this respect, that he placed the loop retrocolically. Polya, in 1911, de-

scribed a procedure which is identical with the operation described by Reichel in 1908 (Fig 228) Stumpf, in 1908, described the method of partial gastrectomy as used by Hoffmeister, of Stuttgart Hoffmeister began this method in 1905, and it consisted of a partial gastrectomy, plus blind closure of the duodenal stump, plus closure of the upper end of the

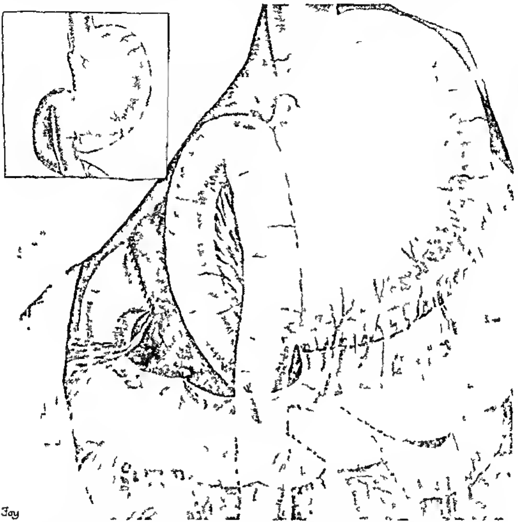

Fig 228 Modification of Billroth II *Insert*— Billroth II retrocolica oralis inferior (known as the "Hoffmeister Finsterer method) *Main picture*—' Billroth II retrocolica oralis ' (known as the "Polya method)

stomach-stump, plus end-to-side gastro-jejunostomy retrocolica inferior This is the operation which, as mentioned before, was done in 1888 by Von Eiselsberg, with the difference only that Hoffmeister placed the loop retrocolically Sasse, of Frankfurt on the Main, in 1909, published a report of twelve cases in which he closed the upper end of the stomach and sutured the lower end of it to the jejunum which was brought behind the colon

He also did not mention the names of his predecessors in this method, evidently being convinced that he was the originator of the method.

A. von Bergmann, of Riga, performed several partial gastrectomies after 1900 in the following manner: A partial gastrectomy, plus blind closure of the duodenal stump, plus end-to-side gastro-jejunostomy retrocolica, utilizing either the entire length of the opening of the stomach or only its lower end. He also does not mention any names connected with the method, evidently being convinced that he was the originator of the method. As may be seen, he antedated Hoffmeister. He, however, introduced a very helpful technical improvement, namely, the making of a seromuscular suture between the jejunum and the stomach before the portion of the stomach was removed.

Burk, in 1911, published the work done at Hoffmeister's clinic and mentioned that Hoffmeister usually sutured the lower end of the stomach to the jejunum brought retrocolically, but that in some cases he used the entire length of the open end of the stomach. If, however, he could not bring the jejunum retrocolically, he took a long loop of the jejunum and brought it in front of the colon and supplemented it with a Braun's entero-anastomosis. Thus, what is known as the Balfour modification of Polya's method has been described not only before Balfour described his modification of Polya, but even before Polya described this method.

Finsterer, in 1913, described his new method. It consisted of a partial gastrectomy, plus blind closure of the duodenal stump, plus blind closure of the upper end of the stomach-stump, plus end-to-side gastro-jejunostomy retrocolica. As may be seen, there is nothing new in his method. Summarizing all that is written above, we may say, that with the exception of one name, in addition to that of Billroth, namely Von Hacker, there is no justification for using any other name in the different modifications of the Billroth II method. Narath suggested to use descriptive topographical names for all the variations of the Billroth II method.

THE BILLROTH II METHOD AND ITS MODIFICATIONS

1. **Billroth II (original).**

This consists of a resection of the stomach, plus blind closure of the duodenum, plus blind closure of the stomach-stump, plus gastro-jejunostomy antecolica anterior (Fig. 227, a). This method is obsolete.

2. **Typical Billroth II (Braun's modification).**

This consists of a resection of the stomach, plus blind closure of the duodenum, plus blind closure of the stomach-stump, plus gastro-jejunostomy retrocolica posterior (Fig. 227, b). This variation is now known as the "*typical Billroth II method*," and is used *quite frequently*.

3. Resection by the **Billroth II antecolica** oralis.

This consists of a resection **of the stomach,** *plus* blind closure of the duodenal stump, plus end-to-side gastro-jejunostomy antecolica, plus entero-anastomosis (Fig. 229).

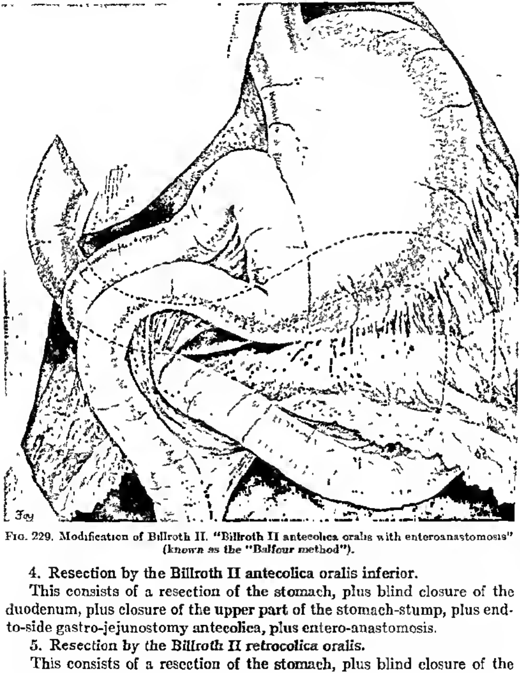

FIG. 229. Modification of Billroth II. "Billroth II antecolica oralis with enteroanastomosis" (*known as the "Balfour method"*).

4. Resection by the **Billroth II antecolica oralis inferior.**

This consists of a resection of the stomach, plus blind closure of the duodenum, plus closure of the upper part of the stomach-stump, plus end-to-side gastro-jejunostomy antecolica, plus entero-anastomosis.

5. Resection by the *Billroth II retrocolica oralis.*

This consists of a resection of the stomach, plus blind closure of the duodenum, plus end-to-side gastro-jejunostomy retrocolica (Fig. 228).

TABLE I. BILLROTH I AND ITS MODIFICATIONS

1. **End-to-end.**—Péan (1879); Rydygier (1880); Billroth (1881). These three authors performed what is known as the "typical Billroth I" operation.

Variations:—Goepel (1923); Horsley (1926); Babcock (1926); Von Haberer (1927).

Gastrectomy with incision of the lesser curvature:—Schmieden (1921); Luquet et Pauchet (1923); Schoemaker (1929).

2. **Side-to-end.**—**Posterior variation**: Kocher (1895). **Anterior variation**: Kustscha-Lissberg (1925); Pototschnig (1930).

3. **End-to-side.**—Von Haberer (1922); Finsterer (1923); Winkelbauer (1927).

4. **Side-to-side.**—Alessandri, Oliani (1924); Leriche (1927).

TABLE II. BILLROTH II AND ITS MODIFICATIONS

1. **Side-to-side**
   - **anterior**
     - **antecolica**—Billroth II (1885); Schiassi "Y" method (1913);
     - **retrocolica**—Dubourg (1898).
   - **posterior**
     - **antecolica**—v. Eiselsberg (1899);
     - **retrocolica**—Braun (1894); v. Hacker (1894).
   - **marginal** V. Mikulicz (1887).
2. **Side-to-end—posterior, retrocolic**—Roux "Y" method (1893).
3. **End-to-end—retrocolica**; Rydygier "Y" method (1904); Moszkowicz (1908); Soresi (1921).
4. **End-to-side**
   - **total oralis**
     - **antecolica**—Kronlein (1887); Balfour; Moynihan II.
     - **retrocolica**—Reichel (1907); Polya (1911); Sasse (1911); Moynihan I. ("Y" method).
   - **partial oralis inferior oralis (idea of V. Hacker 1885).**
     - **antecolica**—v. Eiselsberg (1888); Cunéo "Y" method (1909).
     - retrocolica—Hoffmeister (1905); Wilms (1911); Finsterer (1911).
   - **Superior oralis**—Schmieden (1921).

6 Resection by the Billroth II retrocolica oralis inferior

This consists of a resection of the stomach, plus blind closure of the duodenum, plus closure of the upper end of the stomach, plus end to side gastro jejunostomy retrocolica (Fig 228, insert) The names in "3," "4," "5" and "6" were suggested by Narath, of Heidelberg

As many of these modifications are familiar to surgeons by the names of different men who are justly or unjustly connected with the method, we attach a table, taken from the excellent monograph of G Cavina on Gastrectomy

TOTAL GASTRECTOMY

The first case of a total gastrectomy was performed on a human by Phineas S Conner, of Cincinnati and the report thereof read before the Cincinnati Academy of Medicine, on November 3, 1884 The patient expired on the table after total removal of the stomach, but before the cardiac end of the esophagus was sutured to the bowel After this, several unsuccessful attempts at performing a total gastrectomy were made The first successful total gastrectomy was done by Carl Schlatter, of Zurich, at that time assistant of Prof Kronlein, on September 6, 1897 He closed the duodenum blindly and sutured the cardiac end of the esophagus to the jejunum placed in front of the colon The patient lived more than a year and died from carcinoma The second successful case of a total gastrectomy was done by Charles Brook Brigham in 1898 There are two distinct views as to what constitutes a total gastrectomy

a Kronlein believed that a gastrectomy was total if the entire stomach was removed, so that on the proximal part was left the abdominal portion of the esophagus and on the distal the first portion of the duodenum

b Billroth believed a gastrectomy to be total, if the cardia and the distal portion of the pylorus were still left in situ

To perform a gastrectomy, in the meaning of Billroth, is mechanically easier, and secondary anemia usually does not follow the operation In case of a total removal of the stomach in the meaning of Kronlein, the patient frequently loses appetite, pepsin hydrochloric acid digestion is disturbed, and very frequently he develops marked symptoms of secondary anemia to which he succumbs unless liver-treatment is instituted The explanation why these symptoms do not ensue in all cases of total gastrectomy in the Kronlein sense is, that occasionally some gastric mucosa is found in the abdominal portion of the esophagus If even a very small amount of gastric mucosa is left, the physiological functions of the stomach are not disturbed Up to the year 1928, Finney collected from the literature 122 cases of total gastrectomy, of which 67 were performed in the manner of Kronlein and 55 in the manner of Billroth

TECHNIC OF GASTRECTOMY

The technic varies, depending on:

a. The cause for the gastrectomy.
b. The seat of the pathology.

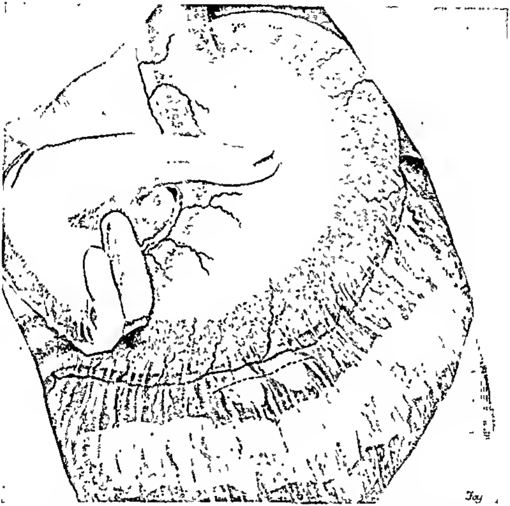

FIG. 230 Partial gastrectomy. Division of the gastrocolic ligament. Two fingers separate the gastrocolic ligament from the transverse mesocolon.

a. If the gastrectomy is performed on account of the presence of a gastric or duodenal ulcer, some surgeons do not ligate the right and the left gastro-epipolic arteries, since a part of the blood-supply to the great omentum takes its origin from these two arteries and after they are ligated the great omentum loses its luster. If, however, the gastrectomy is performed on account of carcinoma of the stomach, these blood vessels are ligated.

b Some surgeons begin the dissection from the point where the pathological portion is located They perform first the most difficult part of the operation If they have been able to separate this pathologically changed portion from the surrounding viscera, then they know that the case is mechanically operable and they proceed with the further steps of the *removal of the stomach*

The other group of surgeons proceed precisely in a reversed order They begin at first the separation of the healthy tissues thus making the stomach more movable, and this facilitates the removal of the diseased portion of the stomach

PARTIAL GASTRECTOMY BY THE BILLROTH II METHOD (RETROCOLICA ORALIS METHOD)

This method is also known as the Polya method However as mentioned already in the historical part of this chapter, it had been employed by several surgeons long before Polya described it

Step 1 Division of the gastro-hepatic and the gastrocolic ligaments (Fig 230)

The gastro hepatic ligament is torn by the index and middle fingers of the left hand These two fingers then pass behind the stomach until the gastrocolic ligament is reached which will lie in front of the fingers, while the transverse mesocolon with its important middle colic artery will lie behind the fingers (Fig 230) The gastrocolic ligament is then divided in sections between two clamps for the desired length (Fig 231) The two fingers which lie behind the gastrocolic ligament in the bursa omentalis serve to prevent injury to the middle colic artery

[Alternate method of division of the gastrocolic ligament (Fig 144)

The gastrocolic ligament is grasped by two tissue forceps and cut very carefully between them The index finger of the left hand is inserted into *the opening and gently separates the gastrocolic ligament* (which lies in front of the finger) from the transverse mesocolon (which lies behind the finger) The gastrocolic ligament is then clamped in succession by artery forceps and is cut between each two of them precisely as described in the previous method]

Step 2 Ligation of the right gastro-epiploic artery

A curved forceps holding a thread passes between the artery and the lower border of the first portion of the duodenum Another thread is carried through the same opening and the artery is ligated by these two threads at a distance of three fourths of an inch from each other The artery is cut between them leaving the larger stump on the duodenal side The ends of the thread are cut short (Fig 232)

Step 3. The left gastro-epiploic artery is ligated in the same manner as the right (Fig. 232).

Step 4. The right gastric artery is ligated by passing two threads with a curved forceps just above the upper margin of the first portion of the duodenum. The artery is then divided between the two ligatures (Fig. 232).

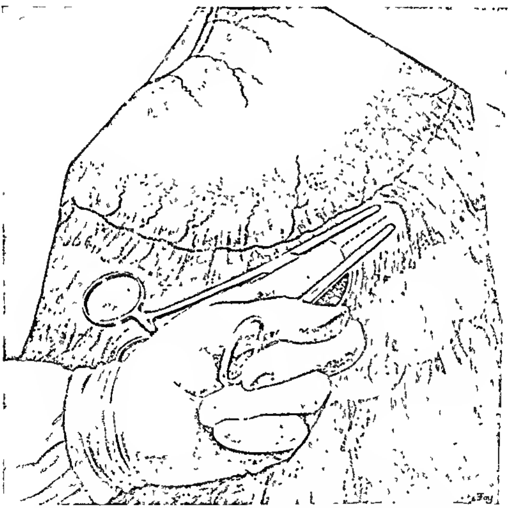

FIG. 231. Partial gastrectomy. Division of the gastrocolic ligament.

Step 5. The opening in the gastro-hepatic ligament, which was made in Step 1 of this operation, is now enlarged by dividing the ligament between the clamps (Fig. 232).

Step 6. A Payr enterotribe clamps the first portion of the duodenum and an artery-forceps clamps the pylorus very close to the Payr clamp (Fig. 233, insert). A laparotomy sponge is placed behind the pylorus. The

first portion of the duodenum is cut between the Payr and the arterial clamps very close to the former ("shave it off") It is cut by a knife, or still better by a Paquelin cautery If it has been cut by a knife, the exposed mucosa of the duodenum on the blade is disinfected by iodine and alcohol The open end of the duodenum is closed by the "over the clamp"

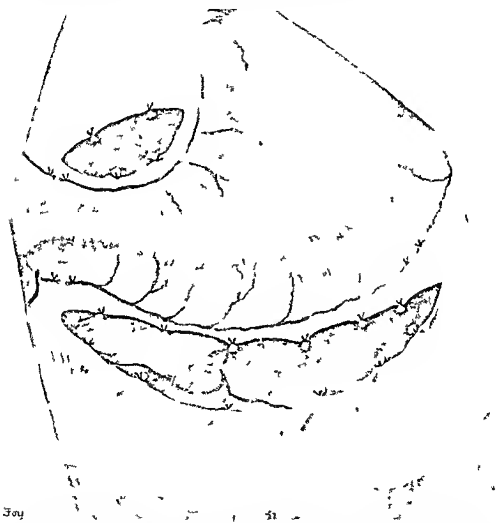

FIG 232 Partial gastrectomy The gastrocolic and gastro-hepatic ligaments divided The right and left gastro-epiploic arteries and the right gastric artery are divided and ligated

method (Fig 114), and is sutured to the pancreatic capsule, thus causing it to lie retroperitoneally

Step 7. Ligation of the left gastric artery (Fig 233, main picture)

The divided portion of the stomach is drawn to the left and is used as a handle The left gastric artery is now ligated precisely in the same manner as described in the ligation of the other vessels of the stomach

The branches close to the stomach are ligated, if the gastrectomy is done for an ulcer, and far away from the stomach, just distally from the origin from the celiac artery, in case the gastrectomy is done for carcinoma of the stomach. The proximal end of the left gastric artery is ligated first by a double ligature and then more distally by a single one.

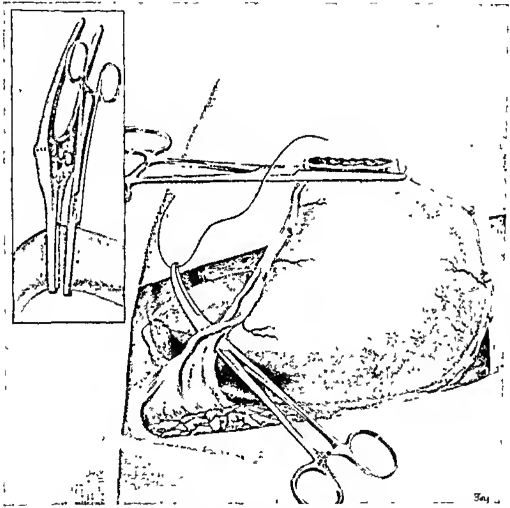

FIG. 233. Partial gastrectomy. *Insert*—Division of the pyloro-duodenal junction. *Main picture*—Ligation of the left gastric artery.

Step 8. An opening is made in the transverse mesocolon, precisely in the same manner as described in posterior gastro-jejunostomy. The first loop of the jejunum is located and is brought through the opening in the mesocolon to the posterior wall of the stomach, so that the proximal end of the jejunum is brought to a point close to the lesser curvature and the distal end close to the greater curvature of the stomach. Each end of the

jejunum is attached to the stomach by an interrupted suture A sero serous suture is then made between these two viscera (Fig 234) A sero muscular incision is then made on the jejunum and on the stomach The blood vessels lying in the mucosa of the stomach are ligated (Fig 234) A seromuscular suture is made between the lips of the jejunum and

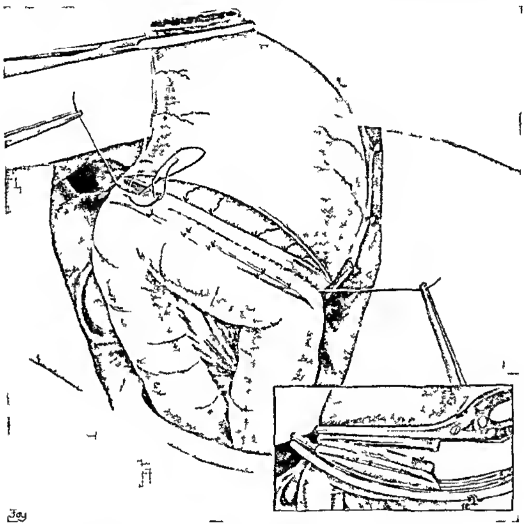

Fig 234 Partial gastrectomy Suturing the stomach to a jejunal loop brought retrocolically

stomach The seromuscular surface of the anterior wall of the stomach is now cut, and the blood vessels in the mucosa are ligated

Step 9 An intestinal clamp is placed on the stomach and another on the jejunum behind the seromuscular suture line and a Payr clamp grasps the stomach just distal to the exposed mucosa (Fig 234, insert) [This will prevent the soiling of the operative field when the portion of the stomach is removed]

Step 10. The stomach is cut away just below the Payr clamp (Fig. 234, insert). While doing this the outer lip of the stomach is caught by a few Allis forceps so as to prevent slipping of the outer stomach-lip behind the intestinal clamp.

Step 11. An incision is made through the mucosa of the jejunum. The length of this incision is a trifle shorter than that of the seromuscular incision (one-fourth inch shorter on each end). The opening of the stomach is sutured to the opening of the jejunum in the same manner as described in the technic of posterior gastro-enterostomy.

Step 12. The edges of the opening of the mesocolon are sutured to the stomach, if it is possible to bring the stomach down without undue tension. If, however, this is not possible, the mesocolic slit is sutured to both limbs of the jejunum.

FUNDUSECTOMY (FIG. 235)

This is the removal of the greater portion of the fundus of the stomach The theoretical ground for this operation, as propounded by its originator F. G. Connell, is that it is better to remove the "acid-bearing area" (that is, the fundus) which contains the acid-secreting glands, than to remove the "ulcer-bearing area" (that is the pyloro-antral region), which is mainly the motile portion of the stomach. The technic, according to its originator, is as follows:

Step 1. Ligation of the gastrocolic and the gastrosplenic ligaments between points A and B.

Step 2. The stomach is clamped at a right angle by two stomach-clamps placed so that the tips of the blades will meet one inch away from the lesser curvature.

Step 3. The stomach is cut along the lines AO and BO.

Step 4. One Allis forceps grasps the posterior wall at O, and another the posterior wall at A and B, and the lips of the posterior wall are then sutured to each other.

Step 5. The lips of the anterior wall are sutured to each other, and the openings in the gastrocolic and gastrosplenic ligaments are closed.

This procedure seems to be a logical one. However, too few cases have been reported thus far in order to decide definitely whether it will become a commonly used operation.

TECHNIC OF BILLROTH I

(This is the "Original Péan-Billroth" operation.)

Step 1. As Step 1 in Partial gastrectomy by Billroth II.
Step 2. As Step 2 in Partial gastrectomy by Billroth II.
Step 3. As Step 3 in Partial gastrectomy by Billroth II.
Step 4. As Step 4 in Partial gastrectomy by Billroth II.

Step 5. As Step 5 in Partial gastrectomy by Billroth II

Step 6. Mobilization of the duodenum (by the Kocher method) and division of the first portion of the duodenum

The posterior parietal peritoneum is grasped in front of the hilum

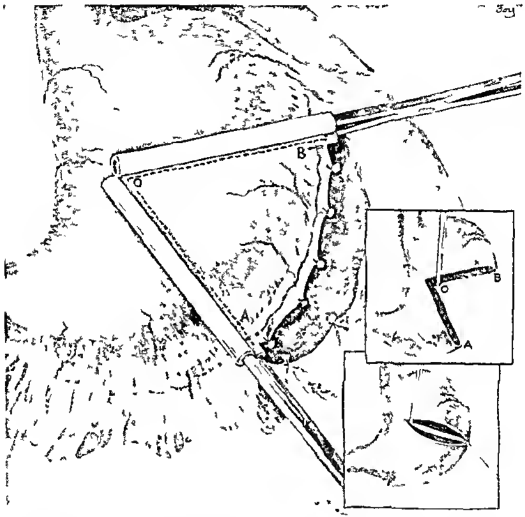

FIG 235 Fundusectomy *Main picture*—The clamps are applied in a proper position *Upper insert*—A portion of the fundus is removed *Lower insert*—Closure of the opening in the stomach

of the right kidney by two Allis forceps and cut by scissors The left index-finger is inserted into the opening thus made and separates the posterior parietal peritoneum from the connective tissue in an upward and downward directions The separated parietal peritoneum is then cut in a vertical direction The index-finger is then inserted behind the duodenum and lifts the latter This constitutes what is known as the "mobilization of the duodenum" The retroperitoneal space is closed, if it is

possible. An artery- or a Payr clamp is placed on the first portion of the duodenum and an artery-clamp on the pylorus. A laparotomy sponge is placed behind the pylorus. The first portion of the duodenum is divided between these artery-clamps very close to the clamp on the duodenal

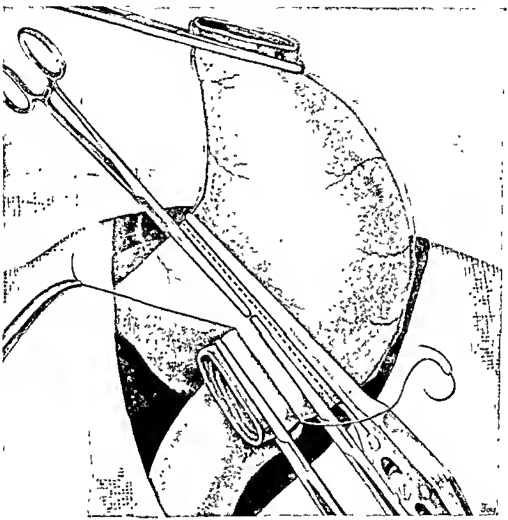

FIG. 236 Partial gastrectomy by Billroth I method. Seromuscular suturing of the stomach *to the duodenum.*

side of the pyloroduodenal junction ("shave it off"). It is cut by a knife, or still better by the Paquelin cautery.

Step 7. Ligation of the left gastric artery.—This is done as in Step 7 of partial gastrectomy by the Billroth II method.

Step 8. An artery-clamp with a four inch blade grasps the stomach immediately distal to the line to be removed and embracing that portion

which adjoins the greater curvature Another artery clamp grasps in the same manner the portion of the stomach adjoining the lesser curvature (Fig 236) The two clamps lie then in such a manner that they form a straight line and embrace the entire circumference of the stomach A seromuscular suture line is made between the duodenum and the portion of

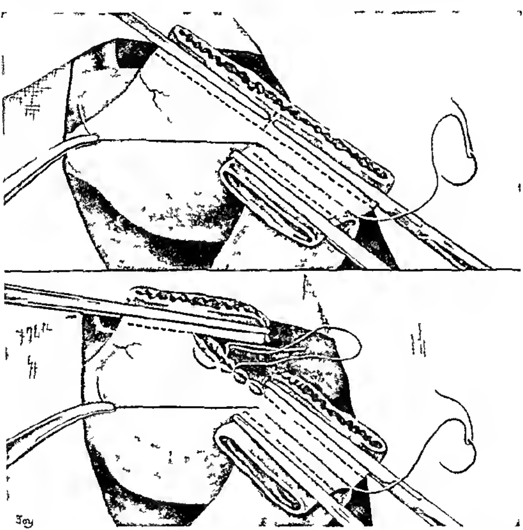

Fig 237 Partial gastrectomy by Billroth I method *Upper half*—The dotted line shows the line of incision *Lower half*—Alternate cutting and suturing of the portion of the stomach adjoining the lesser curvature

the stomach grasped by the clamp which embraces the greater curvature This suture line is made at a distance of one sixth of an inch from the clamp on the duodenum and one third of an inch from the clamp on the stomach A Payr clamp grasps the stomach proximal to the two straight artery-clamps, and the stomach is "shaved off" just beneath the Payr

clamp, between it and the two artery-clamps (Figs. 236 and 237, upper half). If it is cut by a knife, the cut surface of the stomach is disinfected by *iodine and alcohol*.

Step 9. An intestinal clamp covered with rubber tubing is applied to the stomach behind the suture-line. **No clamp is applied to the duodenum.**

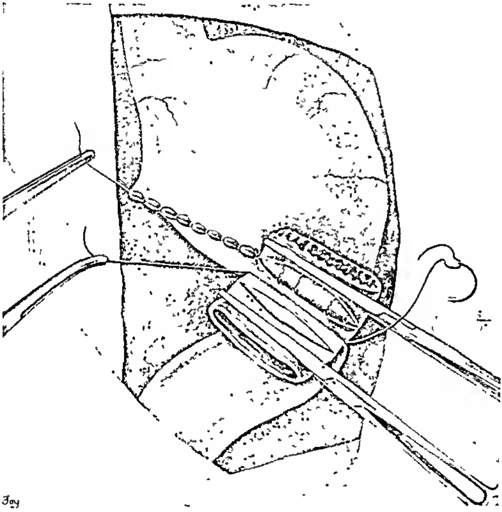

FIG 238. Partial gastrectomy by Billroth I method. The portion of the stomach adjoining the lesser curvature is closed; suturing of the duodenum to the portion of the stomach adjoining the greater curvature.

The upper portion of the stomach is closed in the following manner: A short cut of about half an inch is made beneath the artery-clamp. This opening is then closed. Another cut of half an inch is made beneath the artery-clamp and closed with the same thread. This cutting and suturing procedure is continued until the upper half of the stomach is closed (Fig. 237, lower half). The seromuscular layer of the stomach and that of the

duodenum, is now incised by a knife below the artery clamp (Fig 238) The blood vessels of the exposed mucosa of the stomach are ligated (Fig 238) The seromuscular lips of the stomach and of the duodenum are sutured to each other by a continuous row of sutures Then the mucosa of the duodenum and that of the stomach are cut below the crushing-

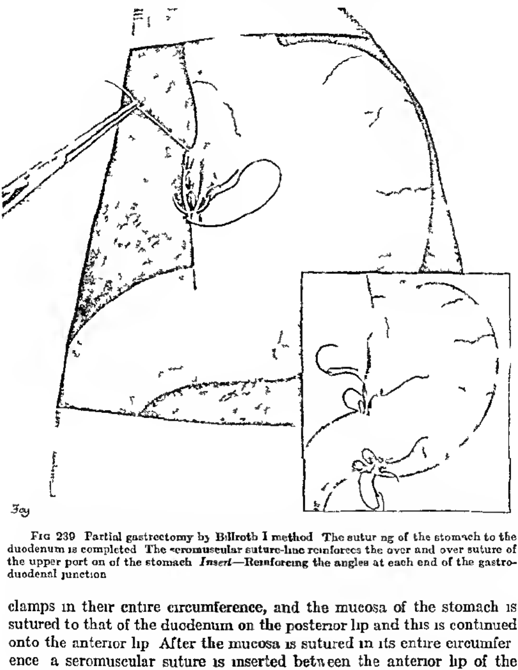

FIG 239 Partial gastrectomy by Billroth I method The suturing of the stomach to the duodenum is completed The seromuscular suture-line reinforces the over and over suture of the upper portion of the stomach *Insert*—Reinforcing the angles at each end of the gastroduodenal junction

clamps in their entire circumference, and the mucosa of the stomach is sutured to that of the duodenum on the posterior lip and this is continued onto the anterior lip After the mucosa is sutured in its entire circumfer ence a seromuscular suture is inserted between the anterior lip of the stomach and that of the duodenum After this the serous suture which

attached the posterior lips of the stomach and the duodenum to each other is continued onto the anterior lip of the stomach and that of the duodenum. This is further continued upward to cover the upper portion of the stomach-stump (Fig. 239). The upper and the lower angles of junction between the stomach and the duodenum are reinforced by a V-suture (Fig. 239, insert).

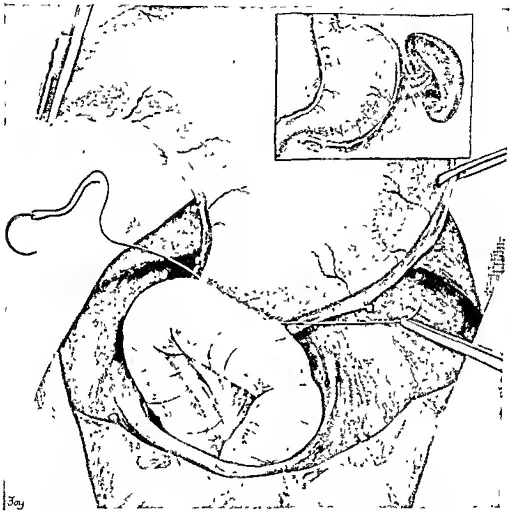

FIG 240. Total gastrectomy. *Insert*—The gastro-splenic ligament is divided. *Main picture*—Suturing of the jejunum to the posterior wall of the cardiac end of the stomach.

TECHNIC OF TOTAL GASTRECTOMY

A total gastrectomy offers more technical difficulties than does a partial or a subtotal. The stomach should be separated from its attachment to the spleen by cutting the gastro-splenic ligament (and great care should be taken not to injure the splenic artery and vein). The methods of re-

establishment of the continuity of the alimentary tract are the same as in partial gastrectomy, namely, the cardia can be sutured to the duodenum or to the jejunum

The mortality rate in total gastrectomy is much higher than in partial gastrectomy and particularly in those cases in which a total gastrec

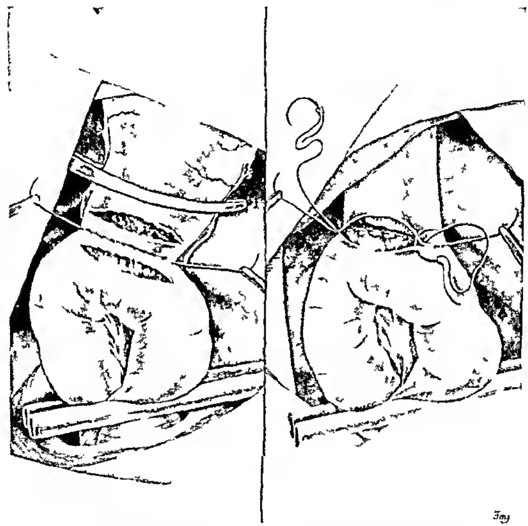

FIG 241 Total gastrectomy *Left half*—The jejunum is incised the stomach is opened *Right half*—The posterior lips are sutured suturing of the anterior lips begun

tomy has been performed in the Kronlein manner in which on the proximal side is left only the abdominal portion of the esophagus which lacks the peritoneal covering and which, therefore, makes the suture-line between the abdominal portion of the esophagus and the duodenum or the jejunum very unsafe In order to overcome this difficulty Goepel of Leipzig suggested forming a seromuscular tube from the uppermost por

tion of the stomach (or the lowermost portion of the cardia), retracting it backward in the form of a cuff for a distance of three-fourths of an inch, then cutting the mucous tube so that it projects beyond the seromuscular cuff for a distance of half an inch, and then suturing the mucous tube to the entire thickness of the wall of the opened end of the duodenum by a

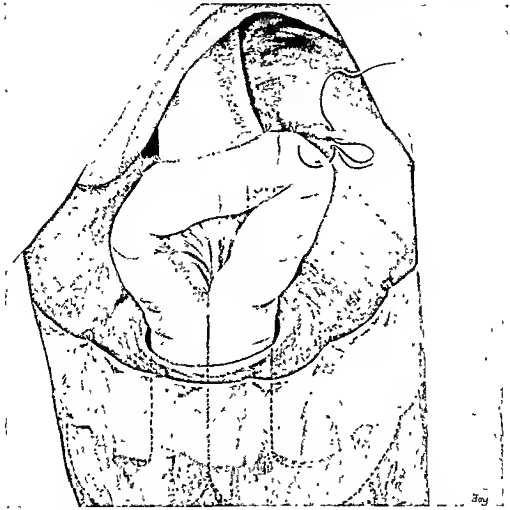

FIG. 242. Total gastrectomy. Suturing of the jejunum to the diaphragm.

through-and-through suture. Then the cuff is replaced in its previous position as a seromuscular tube. The edges of this seromuscular tube are now sutured to the serous surface of the duodenum.

The same suggestion of suturing two hollow viscera, one of which is covered with and the other lacks a serous covering, was described by Felix Mandl and Max Gara, of Vienna, about the same time and independently of Goepel.

Technic.

Steps 1 to 7 are the same as Steps 1 to 7 in partial gastrectomy with this difference only, that the gastro-splenic ligament is cut and the greater curvature of the stomach is freed from its connections with the surrounding structures through its entire length (Fig. 240, insert).

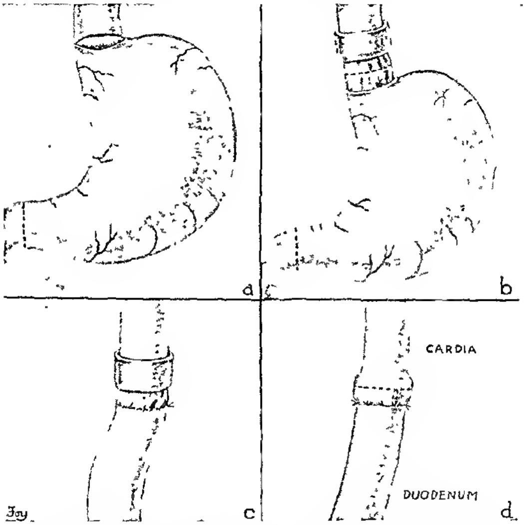

FIG. 243 Total gastrectomy (Goepel method) a Seromuscular incision of the cardiac end of the stomach, b Reflection of the cuff, c Suturing of the cardia to the duodenum, d Serous layer of the cardia covers the cardio-duodenal suture-line

Step 8. A seromuscular suture-line unites the posterior surface of the cardiac end of the stomach to a loop of jejunum brought retrocolically (Fig. 240). A soft-bladed clamp grasps the cardiac end of the stomach about one inch distal from the seromuscular suture-line. An intestinal clamp covered with rubber tubing grasps both jejunal loops at a distance

of four inches from the seromuscular suture-line (Fig. 241, left half). The posterior wall of the cardia and the anterior wall of the jejunum are incised (Fig. 241, left half) and suturing of the posterior lips is begun. After this is completed the stomach is removed by making an incision through the anterior wall of the cardia. A piece of gauze is placed in the cardiac end of the stomach (so as to prevent contamination of the wound). The thread, which sutured the posterior lips by an over-and-over suture, is suturing now the anterior lips (Figs. 241, right half) (the piece of gauze should be removed from the cardia before suture of the anterior lips is completed). The sutured anterior lip is now reinforced by a seromuscular suture.

Step 9. The jejunum is attached to the diaphragm by three sutures, at each side of the cardio-jejunal junction (Fig. 242), in order to diminish the tension on the cardio-jejunal line of anastomosis.

If after total removal of the stomach it is decided to unite the cardia with the duodenum, the Goepel method as just mentioned, may be advantageously employed: A seromuscular circular incision is made at the lowermost portion of the cardiac end of the stomach (Fig. 243, a). The seromuscular flap is reflected in the form of a cuff for a distance of three-fourths of an inch. The mucous layer of the cardia is cut transversely so as to leave a tube of mucosa protruding one-half an inch beyond the cuff (Fig. 243, b). The mucous tube is sutured to the duodenum by an over-and-over suture (Fig. 243, c). The peritoneal cuff is sutured to the duodenum (Fig. 243, d).

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PART IV

CHAPTER XX

SURGERY OF THE GALL-BLADDER AND BILIARY PASSAGES

A. ANATOMY OF THE GALL-BLADDER AND BILIARY PASSAGES. VARIATIONS IN THE COURSE OF THE CYSTIC AND HEPATIC ARTERIES AND OF THE CYSTIC, HEPATIC AND COMMON BILE-DUCTS

The gall-bladder is a pear-shaped sac which is on the average 8 to 12 cm. long and 4 to 5 cm. in its widest portion and, when not distended contains about 40 to 50 c.cm. of fluid. It consists of three portions: the fundus, the body, and the neck, the latter being continued into the cystic duct. The wall of the gall-bladder consists of three layers: the tunicæ serosa, muscularis and mucosa. The mucosa is plicated in numerous folds, which become longitudinal in the neck, and finally form a spiral-shaped fold—the spiral valve **(Heister valve)**, which reaches the cystic duct and occasionally continues into it.

The fundus of the gall-bladder usually lies free and projects in front of the anterior border of the liver. The body is attached to the substance of the liver (the "bed of the gall-bladder"). The visceral peritoneum which covers the liver, passes onto the inferior and lateral surfaces of the gall-bladder, binding it down to the liver-substance. This peritoneum covers nearly the entire gall-bladder with the exception of its superior surface, where it is attached to the liver. Occasionally it surrounds the gall-bladder entirely, and thus the gall-bladder may be surrounded as it were by a meso-gall-bladder.

TOPOGRAPHICAL ANATOMY

Holotopic Considerations.

The gall-bladder is situated in the right half of the epigastrium.

Skeletotopic Considerations.

The fundus of the gall-bladder lies at the point where the lateral border of the right rectus muscle crosses the cartilage of the eighth or ninth right rib.

Syntopic Considerations.

The upper surface of the body of the gall-bladder lies in contact with the substance of the liver. The lower surface of the fundus rests on the right colic flexure (hepatic flexure of the colon), and the lower surface of the body rests on the pars superior duodeni.

Abnormalities

The gall bladder is occasionally absent. Occasionally, there are two separate, independent gall bladders.

Cystic Duct

The cystic duct is usually S-shaped and joins the main hepatic duct at an acute angle, thus forming the common bile duct. This is, however, true only in 75 per cent of all cases. In the rest of the cases there are variations which will be discussed later. The average length of the cystic duct is 4.6 cm., the length ranging usually from one and a half to eleven centimeters. The main hepatic duct is formed by the union of the right and left hepatic ducts, each of which is an excretory duct for the corresponding lobe of the liver. The hepatic duct runs as an unpaired trunk for a few centimeters when it is joined by the cystic duct to form the common bile duct. However, in some cases the right and the left hepatic ducts join each other in the substance of the liver, forming there the main hepatic duct, so that outside of the liver, there is seen only the main hepatic duct.

The average length of the main hepatic duct is about 4.5 cm., being in some cases as short as 2 cm. and in others as long as 9 cm. The common bile-duct is formed by the union of the cystic and the main hepatic ducts. After it is formed, it runs along the outer border of the hepatoduodenal ligament, and is subdivided into the supraduodenal, retroduodenal, and intraduodenal portions. In its retroduodenal portion the common bile duct usually lies in the substance of the pancreatic tissue and occasionally in a deep groove or in a shallow furrow on the posterior surface of the pancreas. The average length of the common bile duct, according to Langenbuch, is 8 cm. Most frequently the pancreatic duct (Wirsungian duct) joins the common bile duct in the wall of the duodenum, namely, in the diverticulum duodeni (ampulla Vateri). However, quite frequently the Wirsungian duct joins the common bile duct outside of the duodenum. In such cases, they enter the ampulla Vateri by a common opening.

In some cases these two ducts run independently of each other, although in very close proximity, and independently penetrate the ampulla Vateri. Each then has its own opening, these being separated from each other by a transverse mucous fold. In some cases the accessory pancreatic duct (ductus Santorini) joins the common bile duct, whereas the Wirsungian duct runs the entire length separately.

The diverticulum duodenale (or ampulla Vateri) is a hollow cone like sac, which lies in the submucous layer of the duodenum. The size of the ampulla Vateri is, according to Opie, 3.9 by 2.5 mm. In its base lies either the common opening of the common bile duct and of the Wirsungian duct, or their separate openings. In the apex of the cone lies a small opening—

the porus papillaris, through which the mixed bile and pancreatic juice leave the ampulla and enter the lumen of the bowel.

The surgical significance of the course of the common bile-duct and of its close relationship to the pancreas and to the Wirsungian and Santorini ducts is twofold: First, it is a difficult procedure to attack the intrapancreatic portion of the common bile-duct. Second, there is an intimate relationship between diseases of the biliary tract and of the pancreas. Any inflammation of the pancreas may compress the pancreatic portion of the common bile-duct, the walls of which are very soft, and thus produce stagnation of the bile. Any inflammation of the gall-bladder or of the biliary passages may find its way into the Wirsungian duct and produce disturbances of the pancreas. It has been proved many times that the injection of staining-paste through the gall-bladder will reach the Wirsungian duct before it enters the lumen of the duodenum through the porus papillaris.

VARIATIONS OF THE BILIARY DUCTS AND THEIR SURGICAL SIGNIFICANCE

a. Cystic duct. In the majority of cases the cystic duct joins the main hepatic duct at an acute angle (Fig. 244, A). However, in many cases the method of union of the cystic and hepatic ducts is different. One of the earliest writers on this subject, Ernst Ruge, of the Körte clinic, classified all the variations of union of the cystic and hepatic ducts into three types:

Type I—Angular union (Fig. 244, A).

Type II—Parallel course, in which the cystic duct, before opening into the hepatic duct, runs parallel to it for a shorter (Fig. 244, B) or longer distance (Fig. 244, C), ranging from two to six or seven cm. In the majority of cases the parallel portions are long rather than short. The parallel portions of the cystic and hepatic ducts are bound by connective tissue, so that in many cases they can be separated from each other by sharp dissection only, and even then with great difficulty. When the parallel branches of the cystic and hepatic ducts are very long, then they may join each other behind the duodenum in the pancreatic tissues, and in some cases they may join each other even within the wall of the duodenum (Fig. 244, D).

Type III—Spiral type.

In this type of union the cystic duct, before joining the hepatic, passes in front of or behind the latter and courses either on its anterior surface (Fig. 244, E) or on its posterior surface (Fig. 244, F), or continues spirally to the left and opens on the left side of the hepatic duct (Fig. 244, G) or even on the anterior surface of this duct, thus making one-fourth, one-half, or even a complete circle. The frequency of the different types of union of the cystic and hepatic ducts differs according to different investigators.

	No of cases (total)	Normal Angular	Parallel	Spiral
Ruge	43	14(33%)	12(29%)	17(38%)
Kunze	39	20(51%)	19(49%)	—(0%)
Descomps	50	40(80%)	6(12%)	4(8%)
Eisendrath	100	75(75%)	17(17%)	8(8%)
Total	232	149(64%)	54(23½%)	29(12½%)

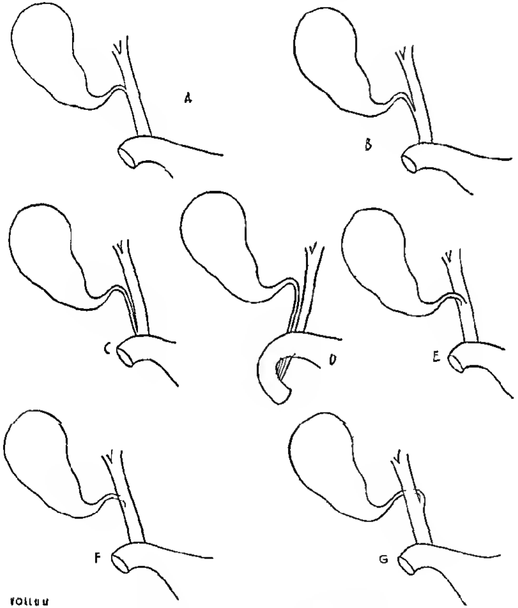

FIG 244 Variations in the course of the cystic duct

The surgical significance of cystic duct variations lies in the fact that it is very easy to injure the cystic, hepatic and the common bile-duct by removing the gall-bladder and that a large portion of the cystic duct may be left behind. A few months after a cholecstectomy has been performed it may dilate and give the same symptoms as the original gall-bladder, similar to attacks of appendicitis after an incomplete appendectomy has been performed.

b. Hepatic duct. Occasionally, the right and the left hepatic ducts join each other in the substance of the liver, and outside of the liver they then present themselves as a single main hepatic duct. In some cases, there are three hepatic ducts, which form the main hepatic duct (Fig. 245, A). Cases have been observed with five hepatic ducts before they united to form the main hepatic duct.

Occasionally, the main hepatic duct is absent. In these cases the cystic duct and two hepatic ducts join each other at a common angle, thus forming at once the common bile-duct.

The surgical significance of this variation is, that if the surgeon wants to drain the main hepatic duct through the cystic duct he will insert a drain into one of the hepatic ducts, thus producing only a partial drainage. Furthermore, if the drainage of the hepatic duct has been made with the intention of diverting temporarily the flow of bile into the common bile-duct after suturing the latter, this aim will not be accomplished.

ACCESSORY BILE-DUCTS

The presence of accessory bile-ducts is not uncommon. Flint in 200 dissected cases found it 29 times, *i.e.* in 14.5 per cent.

These accessory bile-ducta are tributaries either of the right hepatic duct (Fig. 245, A), or of the main hepatic duct (Fig. 245, B), or of the common bile-duct (Fig. 245, C) and even of the cystic duct. They are, on the average, of a fairly good size, being approximately about half of the size of the right or of the left hepatic ducts. However, they may be as large as the size of the right or left hepatic duct or so small as to admit only a bristle into the lumen.

In about thirty per cent of all cases, the accessory duct is a tributary of the right hepatic or of the upper end of the main hepatic duct, and this is of no surgical significance. In about thirty-five per cent the accessory duct is a tributary of the lower part of the main hepatic duct, and in about thirty-five per cent it enters close to the site of union of the cystic and the main hepatic ducts. This is of great surgical significance, since the duct may be easily clamped by the surgeon while performing a cholecystectomy.

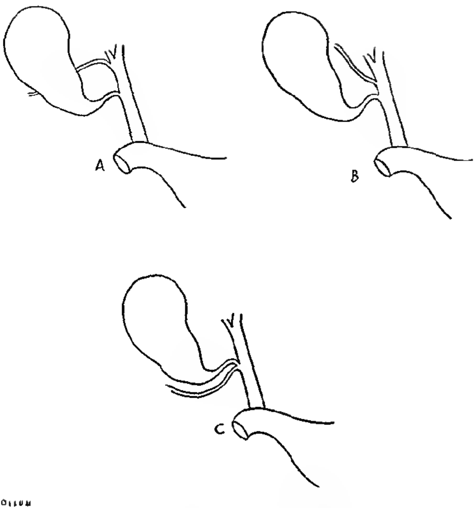

Fig 245 Anomalies of the biliary passages

BLOOD-VESSELS

Normal Arrangement.

The hepatic artery takes its origin from the celiac artery and runs retroperitoneally to the right until it reaches the right gastro-pancreatic ligament which it penetrates, and then turns upward. Before turning upward it gives off the gastro-duodenal artery and a little higher the right gastric artery. Then it breaks into its two terminal branches, the right and the left hepatic arteries, each of which runs to the corresponding lobe of the liver. From the right hepatic artery arises the cystic artery, which runs to the gall-bladder and breaks there into two branches, the anterior and the posterior, which give the blood-supply to the corresponding surfaces of the gall-bladder (Fig. 246, A).

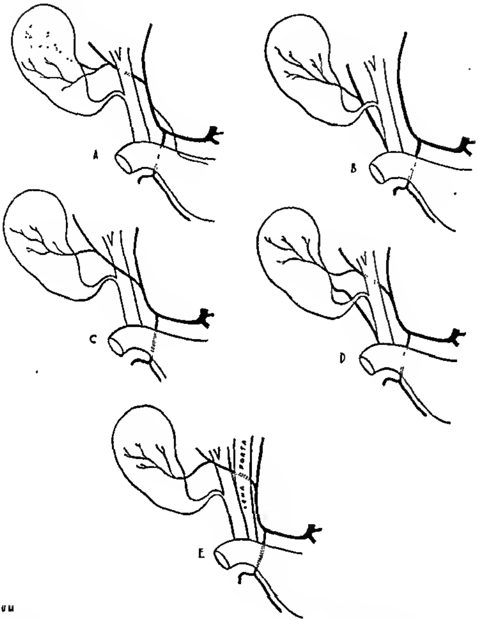

FIG. 246. Anomalies and variations in the course of the cystic and hepatic arteries.

VARIATIONS IN THE BLOOD-SUPPLY

a. The right hepatic artery usually takes its origin from the main hepatic artery. However, occasionally it springs from the aorta, the right gastric, the right renal or the superior mesenteric artery.

The normal arrangement of the branches of the hepatic artery is seen in Fig. 246, A.

The different variations are shown in pictures 246, 247, and 248. Ac-

cording to Flint, based on the dissection of 200 cadavers, the frequency of anomalies of the arteries is:

The right hepatic artery sprang from the main hepatic in 79 per cent and from the superior mesenteric in 21 per cent.

The right hepatic artery before it reached the liver ran behind the

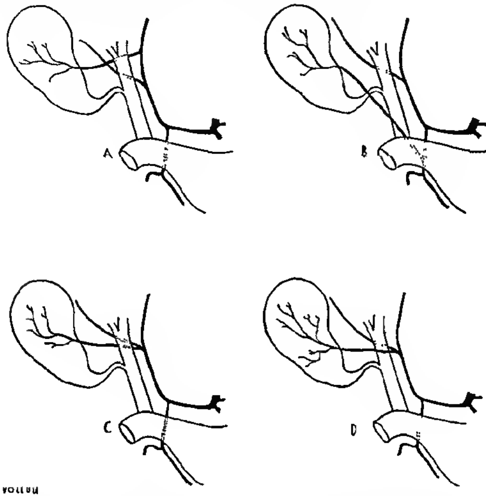

FIG 247. Anomalies and variations in the course of the cystic and hepatic arteries

common hepatic duct in 86 per cent (Fig. 246, A), and in front of it in 14 per cent (Fig. 246, C).

Two right hepatic arteries were present in 3½ per cent, and in each case one took its origin from the main hepatic artery and the other from the superior mesenteric artery (Fig. 246, D).

Two left hepatic arteries were present in two cases, both taking their origins from the main hepatic, one passing in front and the other behind the common hepatic duct. In four cases, the main hepatic or the right hepatic artery also passed behind the portal vein.

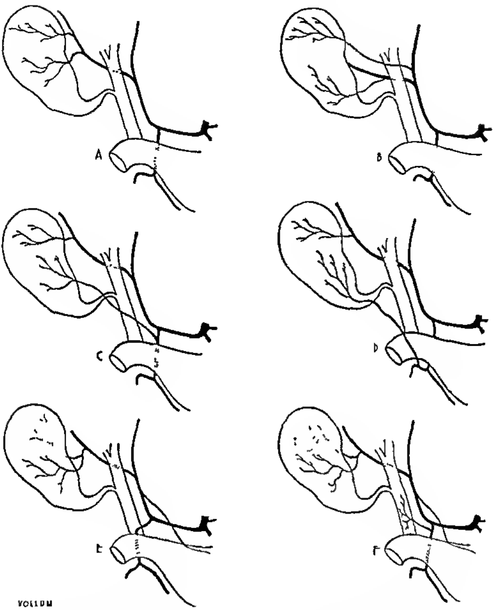

FIG. 248. Anomalies and variations in the course of the cystic and hepatic arteries

b. The cystic artery sprang from the right hepatic artery in 98 per cent (Fig. 246, A), from the left hepatic artery in 1.5 per cent (Fig. 247, A), and from the gastro-duodenal artery in 0.5 per cent (Fig. 247, B).

The cystic artery ran along the right side of the common hepatic duct, or behind it, in 84 per cent and in front of the common hepatic duct in 16 per cent.

An accessory cystic artery was present in 15 5 per cent It arose from the right hepatic artery in 51 6 per cent (Fig 248, A), from the left hepatic artery in 9 7 per cent (Fig 248, B), from the gastro-duodenal artery in 35 5 per cent (Fig 248, C), and from the pancreatico-duodenal artery in 3 2 per cent (Fig 248, D)

If it takes its origin from the gastro duodenal or from the pancreatico duodenal artery (and that occurs in nearly 39 per cent) it is easily liable to injury in *choledochotomy operations*

Whenever there was an accessory cystic artery it invariably crossed in front of the bile-ducts

THE SURGICAL SIGNIFICANCE OF ABNORMALITIES OF BILE-DUCTS AND BLOOD VESSELS

Many difficulties may be encountered by the surgeon in performing operations on the biliary tract

In removing the gall bladder, particularly from below, he is liable to injure the hepatic duct (Fig 244 E, F, G) or the arteries (Fig 246, B D Fig 247, B, Fig 248 C, D) If he clamps the cystic duct far from the point where it joins the hepatic duct, and in many cases even if he cuts close to what appears to him as the point of junction of the cystic with the main hepatic duct, he will leave behind a large cystic duct which will in a few months become distended enough to form practically a new gall-bladder These patients may have attacks of cholecystitis after the gall-bladder has been removed just the same as occasionally, patients have *attacks of appendicitis after appendectomy has been performed* In the latter case, this is the fault of the surgeon who could remove the entire appendix if he would bear in mind that a portion of it occasionally lies under the serous surface of the cecum This is not true, however, in the removal of the gall bladder, since the removal of the spiral cystic duct with a turn of 180° or even of 360°, would offer such great difficulty that it would probably be the wisest thing not to attempt the removal of the spiral cystic duct in its entire length, but merely to cut it off at the point where the neck of the gall bladder joins the cystic duct

Anomalous blood vessels running behind or below the cystic duct are also a source of danger (Fig 246, D, Fig 247, B, Fig 248, C, D)

The cystic, or the right hepatic artery when it crosses in front of the common bile-duct is also a source of danger when choledochotomy is performed (Fig 247, B, Fig 248, C) The same is true when the gastro-duodenal artery makes a curve in front of the common bile duct (Fig 248, E), just as well as in those anomalous cases in which the cystic artery takes its origin from the gastro-duodenal (Fig 248, C), the superior pancreatico-duodenal (Fig 248, D) or the superior mesenteric artery and crosses in front of the common bile duct

The drainage of the hepatic and common bile-ducts is by no means a simple procedure in the "long parallel type" of union of the cystic aod main hepatic ducts.

Removal of stones from the cystic duct of the spiral type, when tbe stones lie in that portion of the duct which is situated behind the main hepatic duct, will result in opening of two ducts instead of one (Fig. 244, F, G). All these possibilities have to he kept in mind by a surgeon hefore he starts any kind of work on the gall-hladder or on the biliary passages.

B. SURGICAL PROCEDURES ON THE BILIARY TRACT

I. CHOLECYSTOTOMY (CHOLECYSTENDESIS)

This is an operation in which the gall-bladder is opened and closed at the same sitting. It has usually been performed for the removal of gall-stones. Van der Wiel, in 1687, was probably the first who performed it on a living human beiog. Later it was entirely forgotten until Meredith performed it in 1883. After opening the gall-hladder and the removal of the stones he closed the gall-hladder. Some surgeons considered this operation as an "ideal cholecystotomy." However, now there can hardly he found any surgeon who would consider this operation ideal. **Whenever the gall-bladder is deliberately opened it should be drained. This means that cholecystotomy should never be performed.**

II. CHOLECYSTOSTOMY

The first deliberately planned cholecystostomy for the removal of stones was done by Jean Louis Petit, in 1743.

Thudichum, in 1859, suggested a two-stage cholecystostomy. In the first stage the gall-bladder was sutured to the abdominal wall, and in the second stage it was opened. As a "one stage" operation, this was first performed by an American surgeon, Bobbs, in 1867, when he thought that he had opened an ovarian cyst. Kocher was the first who, in 1878, performed successfully and deliherately a cholecystostomy in one stage.

Definition.

The term "cholecystostomy" consists of 3 Greek words: *χολή*, bile; *κύστις*, cyst; and *στόμα*, mouth. It signifies an artificial fistula of the gall-hladder, connecting tbe latter with the outside world.

Indications.

1. Gall-stones, with severe infection of the gall-bladder.
2. Any pathology of the gall-bladder usually requiring cholecystectomy, hut associated with pathology of the common bile-duct which cannot be taken care of at the time of the operation. In such a case it would be unwise to remove the gall-bladder on account of a possible future need for it sbould it become necessary to side-track the common bile-duct by performing a cholecysto-enterostomy.

5 In feeble patients in whom cholecystectomy is indicated, but which on account of their weakness must be postponed until some other time

Technic

Abdominal Incision

Different incisions are used for work on the gall bladder We use in our work the Courvoisier or Kausch incision (Fig 36 1 and 3)

Step 1 The abdomen is opened, and the right side of the patient's back is placed in an elevated position either by a sand bag or by lifting the side of a specially constructed table (Fig 249) This simple change

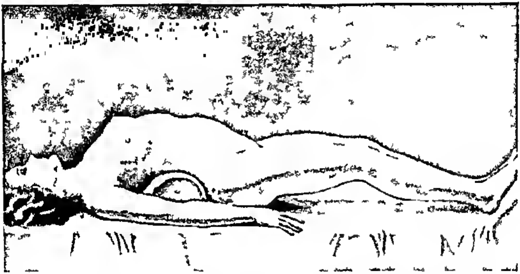

Fig 249 The right side of the chest is elevated (Wheelock Elliot method)

in the position of the patient was introduced by Wheelock Elliot of Boston This brings the liver to the surface of the skin and facilitates all operations on the gall-bladder and liver

Step 2 The round ligament of the liver is grasped by an artery forceps and handed to the assistant who pulls it slightly in the direction of the left shoulder joint of the patient The biliary region is "walled off" from the rest of the peritoneal cavity by placing three laparotomy pads moistened in warm normal salt-solution One pad is laid in the pouch between the inferior surface of the right lobe of the liver and the upper pole of the right kidney (Morison pouch), another, in front of the stomach and the third, below the stomach in front of the small bowel

In order to prevent the loops of the small bowel from appearing in the operative field, we have used for many years the following simple procedure Before placing the third laparotomy pad, we pick up the omentum and spread it carefully over the small bowel Then only do we place in front of it the third laparotomy pad

This simple procedure eliminates entirely the troublesome feature of the small bowel appearing constantly in the operative field.

By placing the three laparotomy pads in the above described manner, the entire abdominal cavity is "walled off" from the operative field.

Step 3. A moist laparotomy sponge with an opening in it, the length

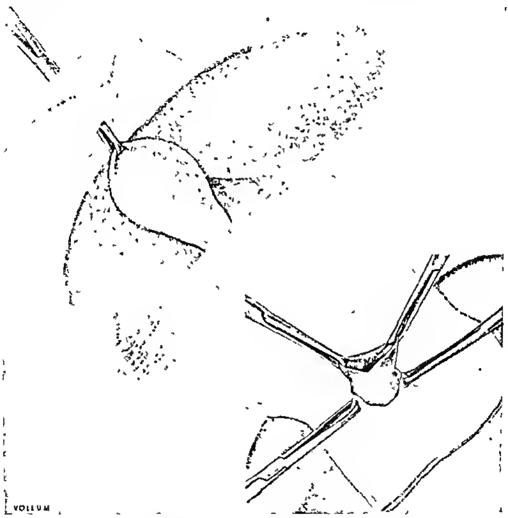

Fig. 250 Cholecystostomy. *Main picture*—Covering the gall-bladder with gauze. *Insert*—The gall-bladder is opened

of which is one inch, covers the gall-bladder in such a manner that the opening corresponds to the place in the gall-bladder where the incision is contemplated (Fig. 250). The sponge is attached to the wall of the gall-bladder by two Allis forceps, and the wall of the exposed portion of the gall-bladder is grasped by two vulsella after which the contents of the gall-bladder are aspirated by a syringe attached to a fine needle.

Step 4. The wall of the gall-bladder is snipped with scissors between the two vulsella for a distance of half-an-inch The vulsella are reapplied by catching the lips of the opening in the gall-bladder (Fig 250, lower *insert*)

A scoop is introduced into the gall-bladder and all the stones are re-

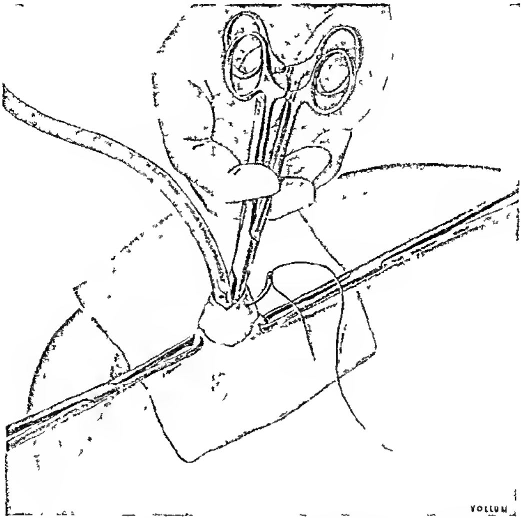

Fig 251 Cholecystostomy Immobilization of the catheter by a transfixing suture

moved The cystic, hepatic and common bile-ducts are then palpated to ascertain whether any *stones are present in them*

If there are any stones, an attempt should be made to "milk" them back into the gall-bladder [We should not be misled by mistaking a calcified lymphatic gland for an intra-biliary stone] If very small particles of stones ("sand") are present, it is best to introduce a piece of gauze and remove them by it

Step 5. A rubber tube with a diameter of about eight millimeters (about one-third of an inch) is introduced into the lumen of the gall-bladder for a distance of one inch. The rubber tube is fixed to the wall of the gall-bladder by a transfixing suture (Fig. 251).

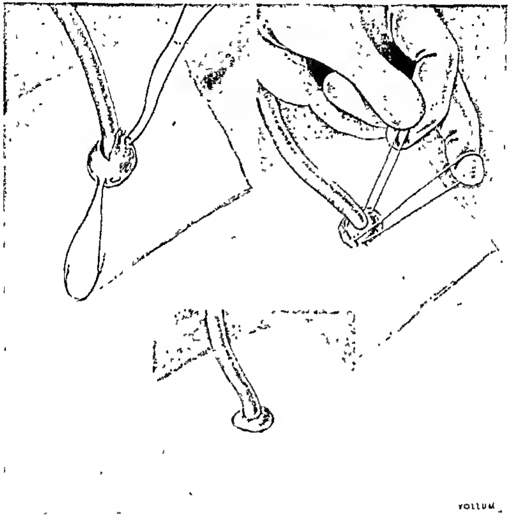

FIG 252. Cholecystostomy. *Left upper insert*—Purse-string suture is inserted. *Right upper insert*—Showing the method of invagination of the catheter *Lower insert*—The catheter is fixed in its final position.

Step 6. A purse-string suture is inserted into the gall-bladder precisely in the same manner as in the Stamm method of gastrostomy, leaving one loop and two long ends (Fig. 252, left upper insert). The purse-string is then tied in the same manner as described in the Stamm method of

gastrostomy This will invert the serous edges of the gall-bladder, which will facilitate the future spontaneous closure of the opening when there is no longer need for a drain (Fig 252, lower insert)

The wall of the gall-bladder should not be fixed to the parietal peritoneum, since fixation causes a dragging pain and occasionally, due to pulling of the gall-bladder, causes kinks in the common bile-duct which may result in an obstruction of the duct

III CHOLECYSTECTOMY

The first cholecystectomy on a human being was performed by Langenbuch, in 1882 On animals it was done as early as in the 17th century. Zambecarri, of Italy, performed it successfully on a dog in 1630

In Switzerland *it was first performed on a human* by Courvoisier in 1885, in France, by Thiriar, in 1885, and in the United States by Ohage, in 1887

Definition.

The term "cholecystectomy" consists of three Greek words χολη bile, κυστις, cyst, and ἐκτομή, excision It signifies removal of the gall-bladder

Indications

1 Primary carcinoma of the gall bladder

2 Chronic and subacute cholecystitis (in acute cases, the operation should be postponed until the acuteness "cools off")

3 Gangrene of the gall-bladder

4 Chronic empyema of the gall-bladder due to stricture of the cystic duct

5 Benign tumors of the gall-bladder

6 Multiple ulcerations of the gall-bladder

7 "Strawberry" gall-bladder [Some surgeons do not consider a "strawberry" gall-bladder as a pathological condition and they advise to leave it alone]

8 Calcification of the gall-bladder

Cholecystectomy should not be performed as the first of a series of operative steps in the case of stricture of the common duct, or in the presence of stones in this duct The pathology of the common bile-duct must first be corrected, since if anything should happen to this duct at the time of its repair after the removal of stones, the surgeon may utilize the gall-bladder for anastomosis with the gastro-intestinal tract **Only after the common bile-duct pathology has been corrected may the surgeon perform cholecystectomy.**

Technic.

Step 1. Abdominal Incision. Various incisions are used (Figs. 36, 37). We prefer either the Courvoisier or the Kausch incision (Fig. 36, 1 and 3). In the case of stout patients the Sprengel incision (Fig. 36, 2) gives additional room.

The position of the patient is the same as in all cases of gall-bladder surgery and has been already described.

Step 2. After the abdomen is opened the gall-bladder and the surrounding viscera should be examined.

First, the stomach should be explored, especially along the anterior and posterior surfaces of the lesser curvature, since in 80 to 90 per cent of all the cases of ulcer of the stomach the ulcer is situated close to the lesser curvature. If an ulcer is present there the surgeon should decide as to the pathology of which organ is responsible for the patient's condition.

If both organs are pathologically altered to about the same degree, the gall-bladder should be removed first and the pathology of the stomach should be corrected at some future time. However, if the operation on the stomach has been deferred, it should never be resumed without checking up, both clinically and roentgenologically, whether the ulcer of the stomach is still present, since cases have been encountered in which a gastric ulcer, definitely demonstrated at the time of the first operation, healed after the gall-bladder and the appendix had been removed.

After the stomach has been examined, the liver should be "rotated." This consists in making the inferior surface face anteriorly. This is accomplished by grasping the anterior border of the liver with the hand covered by moist gauze and drawing the liver upward. The newly acquired position of the liver can be sustained by holding the border of the liver by the hand and by catching with an artery-forceps the round ligament of the liver. This rotation of the liver can be made still more pronounced by passing the hand of the surgeon between the liver and the diaphragm, so that a suction of air takes place. However, this maneuvre should never be tried in the case of an acute condition of the gall-bladder, on account of the possibility of infecting the subdiaphragmatic space, with the subsequent formation of a subphrenic abscess. After "rotation" is done, the gall-bladder should be "walled off" by three laparotomy pads as described above.

Next the cystic, hepatic and common bile-ducts should be examined. The index-finger of the right hand is placed along the lower border of the gall-bladder and is carried in an upward, medial and backward direction until it reaches the foramen epiploicum ("foramen of Winslow"). The common bile-duct is palpated by keeping the index-finger of the right hand in the foramen of Winslow with the thumb of this hand resting on

the ventral surface of the anterior wall of the foramen (Fig 253) [It should be kept in mind that the common bile duct lies in the most lateral portion of the anterior wall of the foramen of Winslow It should also be kept in mind that a calcified gland or glands may be present lying close to

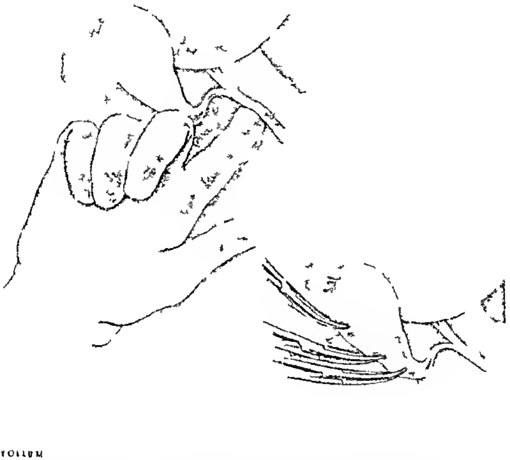

Fig 253 Cholecystectomy *Main picture*—Palpation of the anterior wall of the foramen of Winslow *Insert*—Clamping the wall of the gall bladder

the common bile duct and these should not be mistaken for intrabiliary stones]

If stones are found in the common bile duct their removal from this duct should be undertaken first, and only after this is successfully done should the gall-bladder be removed We should always remember that until it is decided whether the gall bladder should be removed or not, no forceps should clamp its wall

The removal of the gall-bladder can be done from below or from above. The operation from below is neater. However, due to the frequency of anomalies in the course of the blood-vessels and of the biliary ducts, it is safer to remove the gall-bladder from above.

a. Removal of the gall-bladder from above.

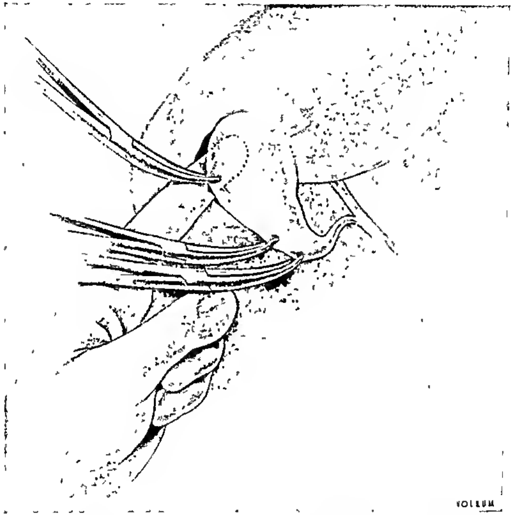

FIG. 254. Cholecystectomy from above. Separation of the gall-bladder from its bed.

Step 3. The wall of the gall-bladder is grasped by an artery-forceps close to the fundus and is put on a stretch by pulling the forceps. With another artery-forceps the lower border of the gall-bladder is grasped about one inch or an inch and-a-half below the first forceps (Fig 253, lower insert).

A fold connecting the proximal portion of the gall-bladder with the duodenum [this is present in 12 to 25 per cent of all cases] is exposed. It

is grasped close to the gall-bladder by a surgical tissue-forceps and is torn down to the neck of the gall-bladder. Usually this is accomplished very easily. If it cannot be pulled readily, then its edge is snipped by scissors and it is separated by the index-finger of the right hand, covered with a piece of gauze. However, before cutting or separating this fold from the

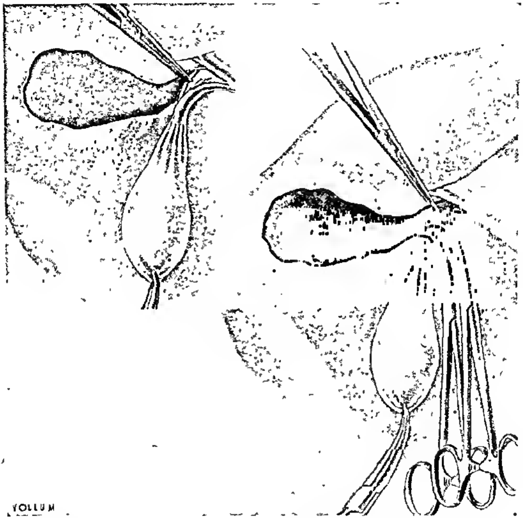

FIG. 255. Cholecystectomy from above. *Upper insert*—Clamping the cystic artery. *Main picture*—The cystic artery is cut; clamping the cystic duct.

gall-bladder it should be palpated, since in anomalous cases a blood-vessel may traverse it in the direction toward the gall-bladder.

After this fold has been severed, the portion of the gall-bladder close to the neck is exposed and the wall of the gall-bladder in this region is grasped by a third artery-forceps. By slight pulling with the three artery-forceps the entire gall-bladder is now well exposed.

Step 4. The upper forceps attached to the fundus of the gall-bladder is gently pulled forward. Thus, the peritoneal fold which connects the gall-bladder with the liver will become stretched and the outline of the gall-bladder wall will be clearly seen. This stretched peritoneum is then

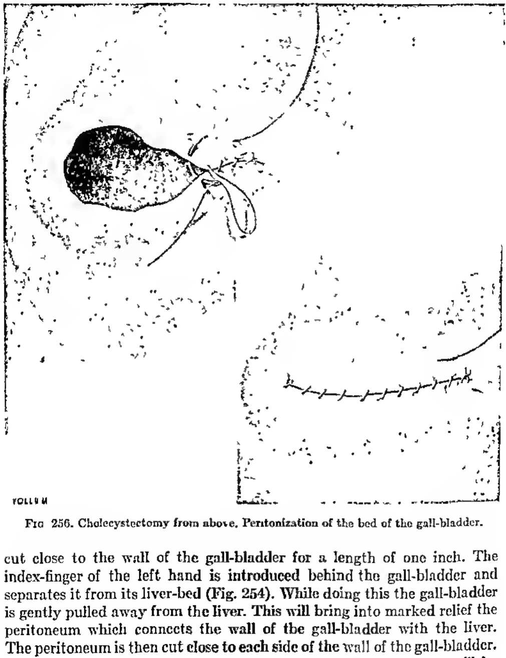

FIG 256. Cholecystectomy from above. Peritonization of the bed of the gall-bladder.

cut close to the wall of the gall-bladder for a length of one inch. The index-finger of the left hand is introduced behind the gall-bladder and separates it from its liver-bed (Fig. 254). While doing this the gall-bladder is gently pulled away from the liver. This will bring into marked relief the peritoneum which connects the wall of the gall-bladder with the liver. The peritoneum is then cut close to each side of the wall of the gall-bladder. When approaching the neck of the gall-bladder a peritoneal fold will be

seen This should be clamped by an artery-forceps, since in it runs the cystic artery (Fig 255, left insert) This fold is cut between the artery-forceps and the wall of the gall-bladder Now the three forceps attached to the gall bladder are gently pulled upward This will expose the cystic

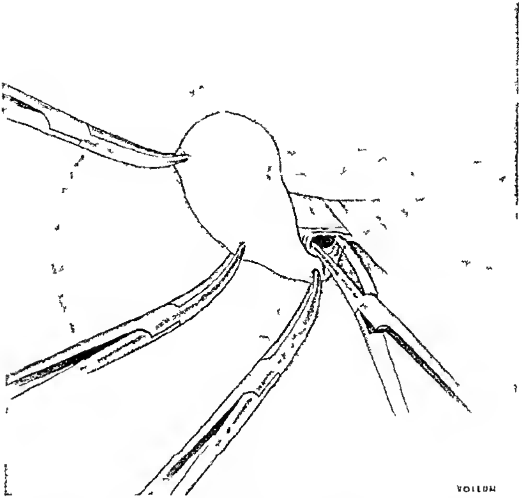

FIG 257 Cholecystectomy from below Separation of the cystic duct from the artery

duct and the place where it joins the hepatic duct in order to form the common bile duct

The cystic duct is now clamped by a curved artery-forceps placed half an inch from its point of junction with the hepatic and common bile-ducts Another curved artery-forceps clamps the duct, which is then cut between the two clamps (Fig 255) The open end of the duct is disinfected by tincture of iodine and alcohol and then ligated by chromic catgut No 1 The ends of the thread are cut short

It is not advisable to ligate the cystic duct either very close to or too far from its junction with the hepatic duct. In the first case, the surgeon is liable to injure the hepatic or the common bile-duct, and in the other case, the remaining cystic duct may expand and become, so to speak, a new gall-bladder.

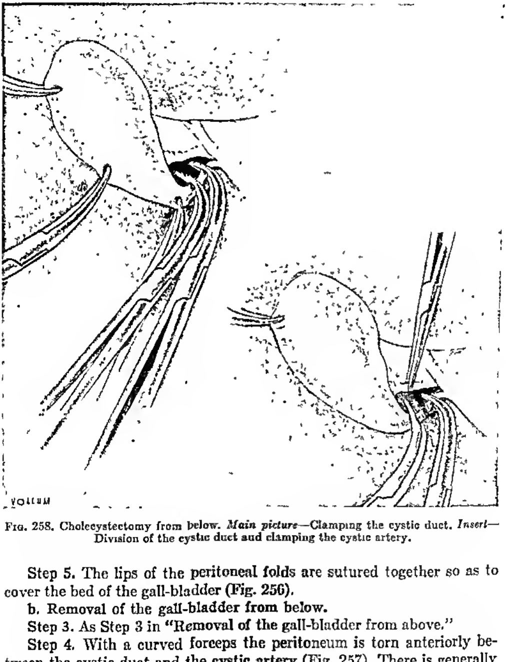

FIG. 258. Cholecystectomy from below. *Main picture*—Clamping the cystic duct. *Insert*—Division of the cystic duct and clamping the cystic artery.

Step 5. The lips of the peritoneal folds are sutured together so as to cover the bed of the gall-bladder (Fig. 256).

b. Removal of the gall-bladder from below.

Step 3. As Step 3 in "Removal of the gall-bladder from above."

Step 4. With a curved forceps the peritoneum is torn anteriorly between the cystic duct and the cystic artery (Fig. 257). There is generally

no danger either of tearing the duct or the artery, since they usually slide away. A curved forceps is then introduced into the slit thus produced between the cystic duct and artery. The jaws of the clamp are then spread sufficiently to separate the cystic duct from the cystic artery for a distance of one inch (Fig. 257). A curved forceps then clamps the cystic duct one-

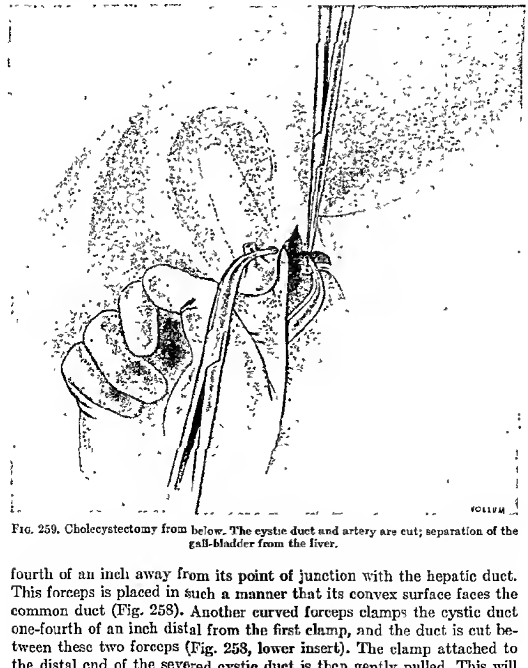

FIG. 259. Cholecystectomy from below. The cystic duct and artery are cut; separation of the gall-bladder from the liver.

fourth of an inch away from its point of junction with the hepatic duct. This forceps is placed in such a manner that its convex surface faces the common duct (Fig. 258). Another curved forceps clamps the cystic duct one-fourth of an inch distal from the first clamp, and the duct is cut between these two forceps (Fig. 258, lower insert). The clamp attached to the distal end of the severed cystic duct is then gently pulled. This will

put the peritoneal folds connecting the gall-bladder with the liver on the stretch. An artery-forceps then clamps the peritoneal fold in which the cystic artery runs (Fig. 258). This fold is then cut distal to the artery-forceps, between it and the wall of the gall-bladder. The index-finger of the right hand is introduced behind the gall-bladder and separates it from

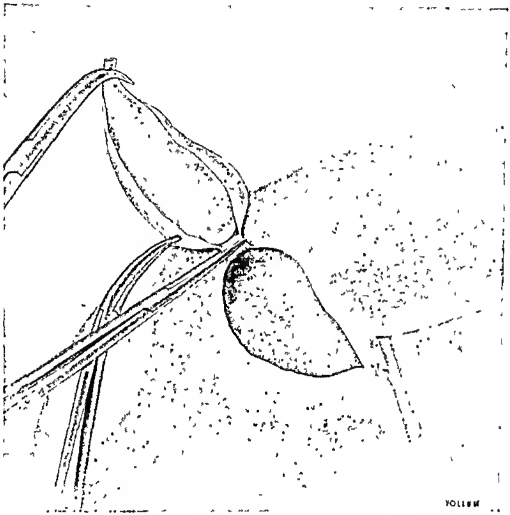

FIG. 260. Cholecystectomy from below. A forceps clamps the peritoneal fold from which hangs the gall-bladder.

the bed of the liver (Fig. 259). The peritoneal folds which extend between the gall-bladder and the bed of the liver are then put on a stretch and cut by scissors. These manipulations are continued until only a very small fold is left connecting the fundus of the gall-bladder with the liver. An artery-forceps then clamps this fold (Fig. 260), which is cut distal to the clamp, thus freeing the gall-bladder from any connections with the liver. The

clamp attached to this peritoneal fold enables the surgeon to hold the liver conveniently while the next step is being performed The cystic artery and the duct are now ligated

Step 5 The lips of the peritoneal folds are sutured together so as to cover the bed of the gall-bladder

In case a ligature slips from the cystic artery, the supposed location of this artery should not be grasped blindly The following should then be done A finger is introduced into the foramen of Winslow and the anterior wall of this foramen is put on the stretch A Spivack non-crushing arterial forceps is introduced into the foramen and clamps its anterior wall This will arrest the hemorrhage The blood is then sponged out, when the cystic artery will be readily seen and may be clamped by an artery-forceps and ligated The Spivack clamp is then removed There is no injury done either to the blood-vessels or to the duct which form the anterior wall of foramen of Winslow, since the Spivack clamp does not damage either the intima of the blood-vessels or the endothelium of the duct

The question of drainage has aroused considerable controversy

The opponents of drainage (followers of the "ideal cholecystectomy") give the following objections to drainage

1 Placing of the drainage tube on the stump of the cystic duct prevents the accumulation of serum and the sealing of the stump, thus inviting a leakage of bile from the cystic duct with the formation of a biliary fistula

2 The drainage-tube weakens the anterior abdominal wall, thus inviting the future development of a postoperative ventral hernia

3 Drainage increases the length of time of confinement to bed

4 Drainage facilitates the formation of adhesions, thus increasing the future morbidity of the patient

For these reasons, many surgeons after removing the gall-bladder close the abdomen completely They are doing an "ideal cholecystectomy" This procedure was inaugurated in Germany as long ago as 1913 However, the objections raised by the opponents of drainage may now nearly all be eliminated Thus

1 There is no necessity for placing the drainage tube on the stump of the cystic duct If bile escapes from the cystic duct is accumulates in the most dependent portion, which is the innermost portion of the Morison pouch For this reason, we place the drain in the innermost portion of the pouch so that it does not touch the stump of the cystic duct at all

2 It is not necessary to bring the drainage-tube out through the original abdominal incision One may pass the drainage tube through a small stab-wound situated midway between the last rib and the iliac crest in the anterior axillary line, and close completely the original abdominal incision This eliminates the objection that the drain prolongs the

time of confinement to bed and tends to the formation of post-operative ventral hernia.

3. The objection that the drain produces adhesions and increases the morbidity is valid.

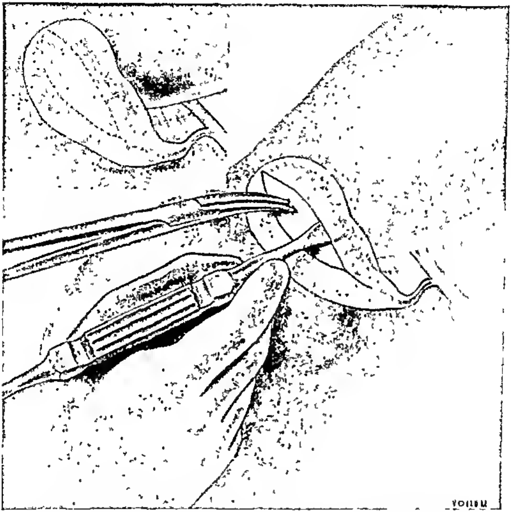

FIG. 261. Subserous cholecystectomy. "Shelling out" the gall-bladder from its serous covering.

This objection is probably the only valid objection suggested by the opponents of drainage. However, the followers of drainage consider drainage of paramount importance, since bile should always be considered septic and as long as there is seepage of bile from the liver it should be drained. Seepage of bile comes not only from the cystic duct from which a ligature has slipped off, but also from the accessory extrahepatic bile-ducts (which were described in the subchapter "Variations of bile-ducts"), and also from the accessory bile-ducts which directly connect the liver-

substance with the gall-bladder and which were torn during the process of removal of the gall-bladder. As in the usual methods of removing the gall-bladder there is no way of preventing tears of the small accessory ducts which directly connect the liver-bed with the gall-bladder, there is nothing else left for the surgeons but to drain, or as an alterna-

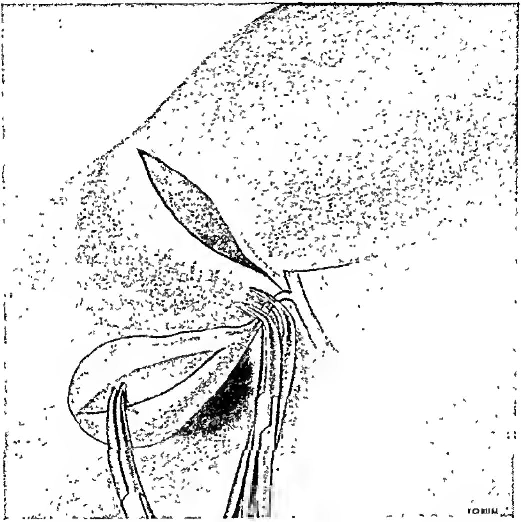

FIG. 262. Subserous cholecystectomy. The gall-bladder is "shelled out", the cystic duct is clamped.

tive to employ those methods which will prevent leakage of bile from the liver.

Two procedures have been suggested to prevent the leakage of bile:

1. Subserous cholecystectomy, in which the serous layer of the gall-bladder is incised and the musculo-mucous layer is shelled out;

2. Mucoclasis (Pribram operation), in which the mucosa and all or a

part of the muscularis are destroyed either by the thermocautery or by diathermy.

1. SUBSEROUS CHOLECYSTECTOMY

The term, "subserous cholecystectomy" was coined by Witzel in 1906.

Fig. 263. Subserous cholecystectomy. Suturing the leaflets of the serosa layer of the gall-bladder to each other.

However, Courvoisier, Langenbuch and others performed it long before Witzel described it.

Technic.

Step 1. The serosa on tbe inferior surface of the gall-hladder is incised in the form of a racquet from the fundus to the cystic duct (Fig. 261, insert). The line of cleavage between the serosa and the muscularis is

found, and the serosa is separated from the muscularis along this line until the musculo-mucous wall is shelled out from its serous covering (Fig 262) The cystic duct is then clamped by two forceps and the gall-bladder is cut between them The cystic duct is now ligated

Step 2. The leaflets of the serosa are sutured to each other (Fig 263)

This method is superior to mucoclasis However, it is not always possible to perform it Then the following method is used by some surgeons

2 MUCOCLASIS (PRIBRAM OPERATION)

This operation was described by Pribram in 1928 At the time of the first publication of his method he had performed it on 200 patients He advocated destroying the mucous membrane of the gall-bladder, without removal of the gall-bladder by sharp instruments such as knives, so that the bed of the gall bladder was left intact He called this operation mucoclasis He advised using the thermocautery for destroying the mucosa of the gall-bladder after ligation of the cystic duct and artery, with subsequent suturing of the remaining seromuscular layer by a serous approximation

However, in a following paper on the same subject, published on April 27, 1929, he advocated the use of diathermy instead of the thermocautery, in order to destroy the inner surface of the gall-bladder by electrocoagulation He used an electrode of 1 by 2 cm in size and advised pressing the electrode against the mucosa with only slight pressure so as not to burn through the entire thickness of the wall of the gall-bladder and injure the substance of the liver P L Mirizzi and F A Olmedo, in November, 1931, published their results in an article entitled "Mucoclasis of Pribram," reporting thirteen cases in which they electrocoagulated the mucosa and muscularis by diathermy and reduced the thickness of the wall by two-thirds All the patients recovered Pop, of Cluj University (Rumania), published, in 1931, the report of 36 cases of mucoclasis as performed mostly by himself in the clinic of Prof Jacobivici He mentioned in this paper that Pribram had already performed 310 operations with 9 deaths (2 9 per cent mortality) In his 36 cases there was not a single death He used the thermocautery in the earlier operations, and electrocoagulation by diathermy in the later cases

Albertin, in 1933, published an additional 10 cases of obliteration of the gall-bladder by the Pribram method without a single death

Step 1. The abdomen is opened, the surrounding structures are examined, and the gall-bladder is walled off from the rest of the peritoneal cavity

Step 2 The gall-bladder contents are aspirated through a two-way syringe (Fig 264) The bladder is washed out several times, first with saline and then with mild antiseptic solution (Rivanol 1 in 1,000)

Step 3. The serosa over the cystic duct is incised and the latter laid bare and cut between two ligatures (Fig. 264). The cystic artery is ligated, when this can be done easily and quickly, but this is not essential.

Step 4. The gall-bladder is opened (Fig. 265), the stones are removed and if possible the proximal cystic stump is excised.

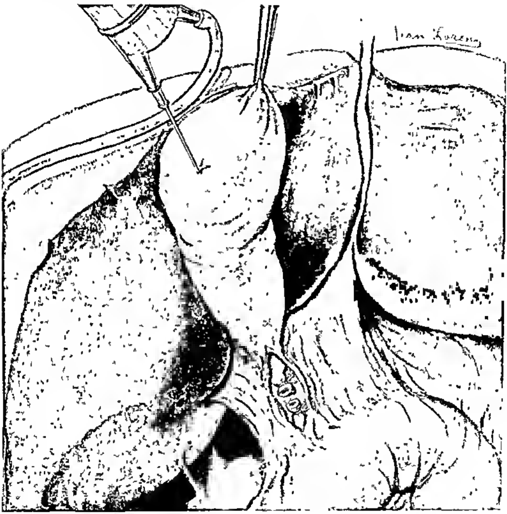

FIG. 264. Mucoclasis operation (Pribram operation).

Step 5. The inside of the bladder is electrocoagulated down to the serosa by an electrode of 1 cm. by 2 cm. (Fig. 265). If, however, it is necessary, one can electrocoagulate down into the liver bed in cases of abscesses or necrosis of the gall-bladder wall.

Step 6. The remnants of the gall-bladder wall are sutured to each other by their serous surfaces. In this way the gall-bladder is entirely obliterated.

Step 7 The abdomen is closed in tiers

Several objections have been raised against the method of Pribram

1 **Opening of the lumen of the gall-bladder** Even after all its contents have been aspirated it is still hazardous to open an infected gall bladder

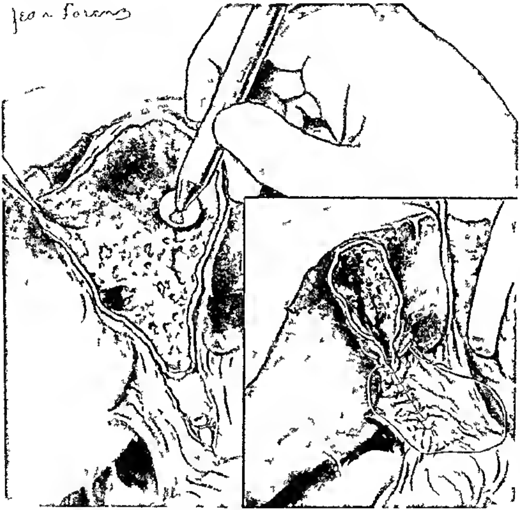

Fig 265 Mucoclasis operation (Pribram operation)

2 Electrocoagulation of the inner layer of the wall of the gall bladder eliminates only one possible source of seepage of bile, by occluding the numerous small bile-ducts running from the liver bed to the gall bladder It will not preclude the possibility of escaping of the bile either through the cystic duct (if the ligature slipped by accident) or through the large *accessory ducts, if they were present and inadvertently cut*

There seems to be a growing sense of disappointment in the results obtained from a cholecystectomy. Many consider the gall-bladder not only as a mere reservoir for bile, but they attach to it an important physiological function. They believe that as long as possible the gall-bladder should not be removed. For this reason, Pribram lately suggested, instead of using cholecystectomy, making a small opening in the neck of the gall-bladder, removing the stones (if they are present), and then performing cholecysto-choledochostomy, an operation which was already performed by Wolff, in 1909. In all the cases that he reported thus far the results have been gratifying. The description of this method will be found under cholecysto-choledochostomy.

Some surgeons advised performing a cholecysto-gastrostomy or cholecystoduodenostomy instead of a cholecystectomy, thus producing "internal drainage of bile." The technic of these procedures will be given below.

IV. CYSTICOTOMY

Definition.

This is the opening and closure of the cystic duct at the same sitting.

Indications.

There are hardly any indications for the performance of this operation. However, it was often used in the pioneer days of biliary surgery for removal of stones in the cystic duct or for hydrops of the gall-bladder due to the obstruction of the cystic duct by stones. This operation was first performed by Lindner, in 1891.

After the cystic duct was exposed it was incised, the stones removed, the opening closed by two rows of catgut sutures, and the gall-bladder drained. Surgeons today prefer to perform a cholecystectomy. With the latest trend in surgery in preserving the gall-bladder, it is highly probable that cholecystogastrostomy and cholecystocholedochostomy will be performed for the cases in which formerly cysticotomy was done.

V. HEPATICOTOMY

This consists in the opening and closure of the hepatic duct at the same sitting. It is usually performed for the removal of stones.

The first hepaticotomy was performed by Kocher, in 1889, unintentionally. He removed a stone, making an incision of a structure that he believed to be the gall-bladder. The autopsy showed that the opened viscus was the hepatic duct.

Usually, after the opening in the duct is closed, the abdominal cavity is drained. This operation is technically difficult on account of poor accessi-

bility of the hepatic duct The best thing to do in the case of a stone in the hepatic duct is to "milk" it into the gall bladder or into the common bile duct

VI HEPATICOSTOMY

This is an artificial communication between the lumen of the hepatic duct and the outside world It was first performed by Knowsley Thornton in 1888 This can be accomplished by opening the hepatic duct and suturing its edges to the anterior abdominal wall In the case of a moderately distended hepatic duct, this is hardly possible In the case of a very dilated hepatic duct it can be easily executed, and this is the manner in which Knowsley Thornton performed it

VII CHOLEDOCHOTOMY AND CHOLEDOCHOSTOMY

Definition

This consists in incising the common bile duct and closing it at the same sitting with (choledochostomy) or without draining the duct (choledochotomy) Langenbuch was the first who suggested it, in 1884, Kummell was the first to perform it in the same year Knowsley Thornton was the first who successfully performed it, in 1889 In case the common bile duct is closed without drainage it is called choledochotomy, and if a drain is placed, one end of which lies in the common bile duct and the other is brought outside of the abdominal cavity, it is called choledochostomy

Indications

This operation is usually done for the removal of impacted stones, which may lie either in

a The supraduodenal portion

b The retroduodenal portion

c The intraduodenal portion of the common bile-duct where the duct traverses the thickness of the duodenal wall

d The diverticulum duodeni (ampulla of Vater)

According to the location of the stone there are described

a The supraduodenal choledochotomy and choledochostomy (Langenbuch operation)

b The retroduodenal choledochotomy (Haasler operation)

c The transduodenal choledochostomy or internal choledochoduodenostomy (Kocher operation)

d The duodeno-choledochotomy or ampullary choledochotomy (McBurney operation)

a. THE SUPRADUODENAL CHOLEDOCHOSTOMY (LANGENBUCH OPERATION).

Step 1. The position of the patient, the abdominal incision, and the "walling off" of the biliary region are precisely the same as in other operations on the gall-bladder and on the biliary passages, and have been already described.

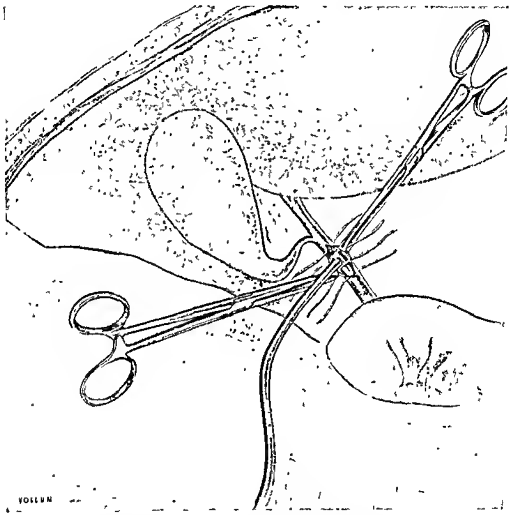

Fig. 266. Supraduodenal choledochostomy (Langenbuch operation).

Step 2. The index-finger of the left hand is inserted into the foramen of Winslow and the duct is palpated between the thumb and this finger. The stone is located and steadied with the thumb and the finger. The wall of the common bile-duct is cut over the stone which is squeezed out.

The edges of the lips of the incised wall of the common bile-duct are grasped by two vulsellum forceps. An L-shaped tube is introduced into

the duct and the other end is brought outside the abdominal cavity The common bile duct is closed snugly around this tube (Fig 266) A soft rubber tube is placed to the right of the common bile duct and the other end of it is also brought outside of the abdominal cavity [N B There is quite a divergence of opinion as to whether the common bile duct should be drained after it is incised Some place a rubber catheter for drainage of the hepatic duct only Some drain only the common bile duct, some place a T tube, draining both the hepatic and the common bile duct some use an L-shaped tube Some do not use a drain in the common bile duct at all being satisfied with placing a drain extrabiliary]

b RETRODUODENAL CHOLEDOCHOTOMY (HAASLER OPERATION)

This was suggested by Haasler, in 1898 The characteristic feature of this procedure is that the second part of the duodenum is mobilized by the Kocher method and the posterior wall of the duodenum is turned anteriorly (Fig 221)

This portion of the duct is either covered by pancreatic tissue or lies in a groove within the pancreas The gland must for this reason either be cut or separated bluntly After the duct is exposed it should be incised the stone removed and the duct sutured A drain should be left in the surrounding tissues

c TRANSDUODENAL CHOLEDOCHOSTOMY OR INTERNAL CHOLEDOCHO DUODENOSTOMY (KOCHER OPERATION) (FIG 267)

This operation was first performed by Kocher in 1894 and was described by him as ' Internal Choledocho duodenostomy It consists in incising the anterior wall of the second part of the duodenum and then the posterior wall, until the duct is exposed lying intramurally and then in opening the common bile duct

This is usually done for removal of stones impacted in the third part of the common bile duct that is in the portion of the duct which traverses the wall of the duodenum

Technic

Step 1 The abdominal incision, the position of the patient and the rotation of the liver are the same as usually in operations on the gall bladder and biliary passages

Step 2 The mobilization of the duodenum by the Kocher method and the bringing of the duodenum to the surface of the skin are done in the manner already described

Step 3 The duodenum is steadied with two fingers of the left hand which hold its wall close to the impacted stone The anterior wall of the

duodenum is cut, and a vulsellum grasps each lip of the wound. A finger is inserted into the lumen of the duodenum and its posterior wall is palpated. If the stone lies close to the ampulla, an attempt is made to extricate it through the ampulla. If the surgeon fails to do this (and that happens most frequently), then the posterior wall of the duodenum and the duct over the stone are cut.

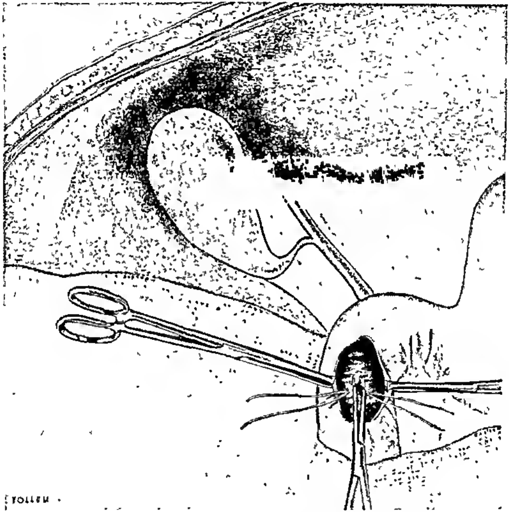

FIG. 267. Transduodenal choledochostomy (Kocher operation).

Two catgut sutures are inserted, one on each lip, which include all the substance between the mucosa of the posterior wall of the duodenum and the stone. Each suture thus includes part of the posterior wall of the duodenum and the anterior wall of the duct. These two sutures are used as traction-sutures and facilitate the removal of the stone. After the latter is removed, it is important not to suture the lips, that is, to leave them

open. Thus, a choledocho-duodenostomy has been performed. If, however, in order to remove the stone the incision of the posterior wall is continued upward and reaches the retroduodenal portion of the duct, then the lips of the open posterior wall of the duodenum should be sutured to the lips of the opened common bile-duct. Otherwise, leakage of bile and

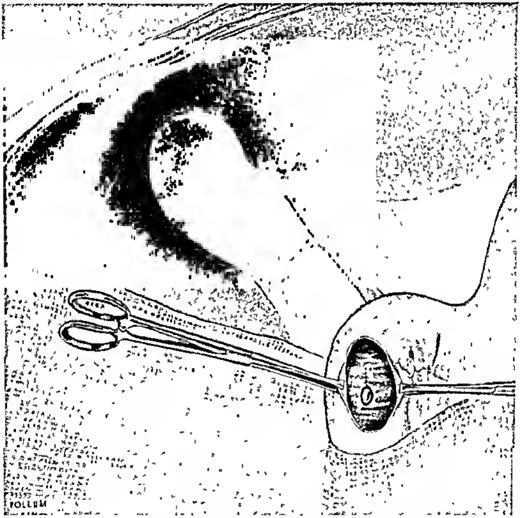

Fig. 268. Ampullary choledochostomy (McBurney operation).

of intestinal contents into the free peritoneal cavity or into the retroperitoneal space will ensue.

Step 4. The anterior wall of the duodenum is sutured in layers. The first is through-and-through and the second seromuscular. The seromuscular suture-line is covered by omentum.

Step 5. The abdomen is closed without drainage.

We must emphasize again, that as the third part of the common bile-duct lies in the thickness of the duodenal wall, in the Kocher operation the posterior wall of the duodenum is cut into, but not through.

d. AMPULLARY CHOLEDOCHOSTOMY (McBURNEY OPERATION) (FIG. 268)

This consists in opening the anterior wall of the duodenum in order to expose the ampulla Vateri and then in cutting through the lip of the opening (porus duodeni) followed by the extraction of the stone.

After the stone is removed, the incised lip of the ampulla is not sutured (otherwise stricture of the porus duodeni may ensue), but the incised anterior wall of the duodenum is, of course, closed.

VIII. RECONSTRUCTION OF THE BILIARY TRACT

Numerous procedures have been described to reëstablish the flow of bile into the alimentary tract in case the patency of the duct has been lost from any cause, or to make new channels for the flow of bile into the alimentary tract. These numerous methods can be grouped into several classes:

1. Reconstruction of the biliary tract by excision or by plastic methods.

A. Excision of the constricted portion of the bile-duct with end-to-end anastomosis of the divided ends.

a. Direct end-to-end anastomosis.

b. Indirect end-to-end anastomosis.

B. Plastic reconstruction of the biliary tract:

a. Incision of the anterior wall of the bile-duct longitudinally with suturing it transversely.

b. Longitudinal incision of the anterior wall of the constricted bile-duct with the introduction into its lumen of a portion of a catheter, and surrounding the opening with omentum.

c. Reconstruction of the biliary tract by a pedicle-flap made from the wall of an adjoining viscus of the gastro-intestinal tract or from the gall-bladder.

d. *Reconstruction of the biliary tract by a flap of different structures* not connected with their mother-tissue (fascia, veins, arteries, etc.) ("Free transplantation").

2. Implantation of a portion of the biliary tract into some portion of the gastro-intestinal tract (stomach, duodenum, jejunum):

a. Direct implantation.

b. Indirect implantation.

3. Direct communication between the liver and some gastro-intestinal viscus.

4. Implantation of an existing external biliary fistula into the gastro-intestinal tract, or the artificial formation of an external biliary fistula with

subsequent implantation of it into the selected hollow viscus of the gastro-intestinal tract

a Direct implantation

b Indirect implantation

1 **Reconstruction of the biliary tract**

Fig 269 Resection of a portion of the common bile duct

A Excision of the constricted portion with an end-to-end anastomosis

a Direct anastomosis In case of impermeability of the common bile-duct the constricted portion may be excised and the remaining portion sutured together

The first end to-end anastomosis of the common bile duct was per formed by *Doyen, in 1892* He sutured the divided ends over a rubber

tube. Körte, in 1898, sutured the ends of the divided duct without the use of prothesis. The technic, as it is used now, is as follows:

Step 1. The abdomen is opened, the patient placed in the proper posture, the operative field isolated, and the surrounding structures examined.

FIG. 270. Indirect reconstruction of the common bile-duct (Propping method).

Step 2. The liver is rotated so as to make the constricted common bile-duct lie as superficially as is possible. Then the common bile-duct is separated from the other structures of the anterior wall of the foramen of Winslow. Two Spivack non-crushing forceps then clamp the common bile-duct, one proximally and the other distally from the site of the stricture (Fig. 269, insert).

Step 3 The stricture is excised

Step 4 *Four fine silk sutures are inserted, which unite the respective* ends of the posterior lips of the divided duct (Fig 269) The ends of these sutures are tied, those of the middle two threads are then cut short and those of the lateral two threads are left long The non crushing clamps are now disengaged An L-shaped tube is inserted in such a manner that the short end of the tube lies in the hepatic duct, the long end of the horizontal portion in the common bile duct, and the vertical portion is brought outside the abdominal cavity

Step 5 A suture is inserted, connecting the anterior lips of the duct on each side of the vertical end of the L-tube The threads are tied and the ends are cut short

The immediate and late results of end-to-end anastomosis are good However, this method should never be employed if there is any tension after the ends are brought together

b Indirect anastomosis of the ends of the divided common bile-duct (Fig 270)

This is usually done when the divided ends are far from each other (more than one third of an inch) It was first performed by Verhoogen, in 1907 Propping, in 1909, performed an indirect anastomosis utilizing a T tube as a bridge in order to connect the separated ends of the divided common bile duct The operation, as performed by Propping, is seen in Fig 270 It is always better to follow the suggestion of Sullivan namely to cover the exposed part of the rubber tube with omentum

The immediate results of the operation are good, but the late results (after 1 to 1½ years subsequent to the operation) are not good, since a stricture of the newly formed channel ensues Therefore, this method should not be used

B PLASTIC RECONSTRUCTION OF THE BILIARY TRACT

a Plastic reconstruction by a longitudinal incision of the anterior wall in the strictured portion and by suturing it in a transverse direction (Fig 271)

This method is analogous to the Heineke Mikulicz method of pyloroplasty, and is best done either over a T tube or over two tubes, one of which is inserted into the hepatic and the other into the common bile duct

The results of this method are good However, it can be used only in those rare cases in which the stricture is short If the latter is long then it is not convenient to use this method, since the points most distant from each other, namely, the upper and lower ends of the stricture cannot be brought together

b Plastic reconstruction by a longitudinal incision of the constricted bile-duct and surrounding the opened duct with omentum

The duct is opened longitudinally. A small portion of a rubber tube or of a catheter is inserted into its lumen and the distal end is brought outside the abdomen. The opening in the duct is covered with omentum or it may be left open. One lip of the duct is then sutured to the other over this rubber tube.

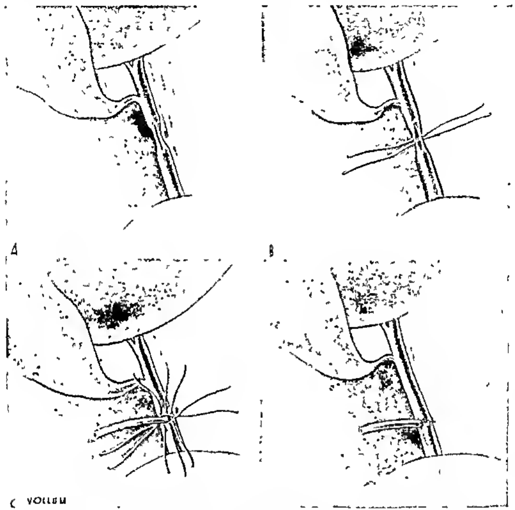

FIG. 271. Plastic reconstruction of the common bile-duct by cutting the duct longitudinally and suturing it transversely.

This method is good as long as the tube stays in. As soon as it drops off stricture ensues.

c. **Reconstruction of the biliary tract by the formation of a pedicle-flap from the wall of an adjoining viscus of the gastro-intestinal tract or from the gall-bladder.**

This consists in making a flap of the entire thickness of a portion of

the anterior gastric wall or of the wall of the gall bladder and in implanting it into the defect of the wall of the common bile duct To Kehr belongs the credit for introducing this method It gives good results and should be considered as a good method

d Reconstruction of the biliary tract by flaps of different structures not connected with their mother-tissue, such as fascia, arterial tubes, venous tubes, etc ("Free transplants")

This method has been used by many surgeons, both on the human and experimentally The transplants were autogenous, homogenous and even heterogenous The results were unsatisfactory and for this reason we do not advise this method at all

2 Implantation of a portion of the biliary tract into a selected part of the gastro-intestinal tract (stomach, duodenum, jejunum)

The portion of the biliary tract selected for implantation may be the gall bladder, the cystic, hepatic or the common bile duct The viscus into which it is implanted may be the stomach duodenum or the jejunum The anastomosis may be direct or indirect In case of a direct anastomosis this may be done by a suture method or by a mechanical device, such as the Murphy button, etc [We always prefer the suture method to any in which a mechanical device is employed]

a Direct implantation of the biliary tract into the gastro-intestinal tract

This is an artificial communication between the lumen of the gall bladder or of the cystic, hepatic or common bile duct and that of the stomach or of the bowel The first cholecysto-enterostomy (it was chole cysto colostomy) was performed by Winiwarter, in 1880, by a six stage method

A Russian surgeon, Monastyrski performed a cholecysto enterostomy (cholecysto jejunostomy) as a one stage operation, in 1887, by a suture method A cholecysto jejunostomy by the 'Y" method was first performed by Monprofit and reported in 1904

The first cholecysto duodenostomy was performed by Bardenheuer in 1888 The first cholecysto-gastrostomy was performed by Gersuny, in 1892, and published by Wickhoff and Angelberger, in 1893 Cholecysto-choledochostomy was first performed by Wolff, in 1909 He did it as a side tracking operation in case of a previously completely divided common bile duct

Pribram, in 1935, suggested the very same operation by making an anastomosis between the neck of the gall bladder and the common bile-duct The reason for using this operation, according to Pribram is that in recent years a close study of the physiology of the gall bladder showed that this organ should be preserved whenever possible and not removed

By making an anastomosis between the neck of the gall-bladder and the common bile-duct the gall-bladder is placed comparatively at rest, and this not only prevents a further development of the pathology of its wall but even an existing pathology may subside. Pribram reported eleven cases treated in this manner with gratifying results. As may be seen, Pribram's cholecysto-choledochostomy is identical with Wolff's, but it is done not as a side-tracking, but as an "internal drainage" operation.

The first lateral cystico-duodenostomy was performed by Mayo Robson, in 1898, and the first hapatico-duodenostomy by Kehr, in 1902. The first lateral choledocho-duodenostomy was performed by Riedel, in 1888.

CHOLECYSTOCASTROSTOMY

The first cholecysto-gastrostomy was performed in 1892 by Gersuny, and the report of this case was made by Wickhoff and Angelberger, in 1893. The object of the operation was to side-track the obstructed common bile-duct. For many years this operation served as one of the sidetracking type of operations.

Wayne Babcock, in 1920, advised using cholecysto-gastrostomy not only as a sidetracking operation, but also for the treatment of a gastric or duodenal ulcer by neutralizing the high acidity of the stomach by the alkaline contents of the gall-bladder.

The same operation for the surgical treatment of gastric or duodenal ulcer was advocated by Bogoras, in 1925, and it is known in Europe as the "Bogoras operation." DuBose, in 1931, advocated the performing of a cholecysto-gastrostomy not only as a sidetracking operation and for the treatment of gastric or duodenal ulcer, but also as an "internal drainage" operation, which should replace the external drainage of bile (cholecystostomy) and cholecystectomy.

Technic (Fig. 272).

Step 1. The abdominal incision and the exposure of the liver are the same as in all gall-bladder operations.

Step 2. A seromuscular suture running in a vertical direction is made between the fundus of the gall-bladder and the stomach for a distance of one and one-half inches. On the stomach, the suture-line is made on the antrum, one inch proximal to the pyloric canal.

Step 3. The stomach and the gall-bladder walls are incised for a distance of one inch. The line of incision on the stomach is at a distance of one-third of an inch from the suture-line, and on the gall-gladder one-sixth of an inch. The mucosa of the stomach is sutured to the mucosa of the gall-bladder by a continuous suture, using chromic catgut number 0. When the suturing of the mucous layer is completed, a seromuscular suture is made between the anterior lips of the gall-bladder and stomach.

Step 4 The suture line is reinforced by covering it with a piece of omentum

Another method of making an anastomosis between the gall bladder and the stomach was described by Stubenrauch in 1905 A flap of the anterior wall of the stomach was made (Fig 273 A) and its free edge was sutured to the wall of the gall bladder (Fig 273 B) The gall bladder was

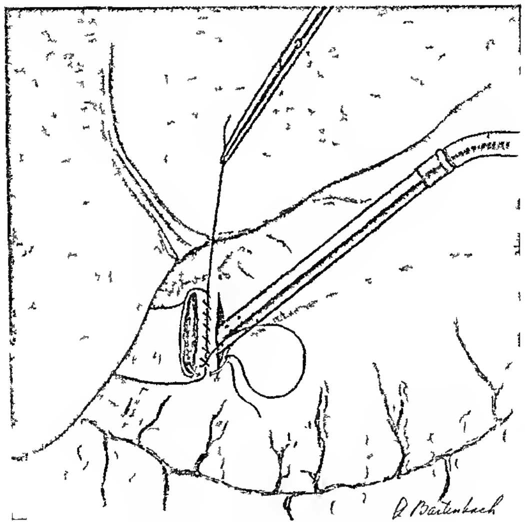

FIG 272 Cholecystogastrostomy by the suture method

then opened so that its lumen communicated with that of the stomach and the flap served as a bridge between these two lumina (Fig 273 C) The flap was then sutured in the form of a tube Thus a tubular communication between the lumina of the gall bladder and stomach was established (Fig 273, C)

One objection is raised against cholecystogastrostomy, namely, the possibility of an ascending cholangitis. Whereas there is unanimity of opinion that this is always present in dog experimentation, its occurrence in the human is much disputed. Some believe that it hardly ever occurs in the human, particularly when the anastomosis is made between the gall-

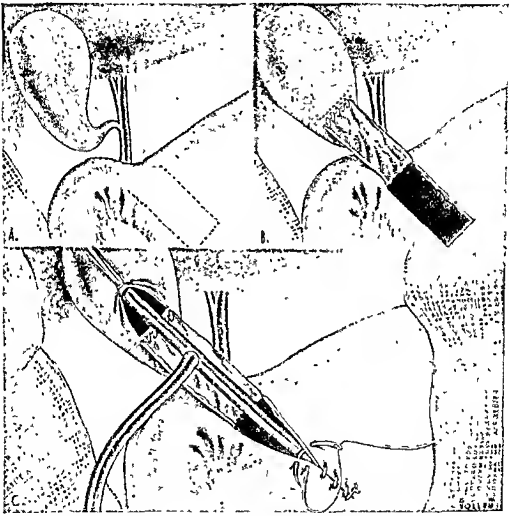

FIG. 273. Cholecystogastrostomy by the Stubenrauch method.

bladder and the stomach and not between the gall-bladder and the jejunum. However, there are reports from several leading clinics that an ascending cholangitis was observed after performing this operation. In order to overcome this difficulty several procedures have been suggested:

a. To make the anastomosis in such a manner that a portion of the gall-bladder shall lie in a channel of the Witzel type formed on the anterior wall of the stomach or of the duodenum (Lambret method).

b. To make the anastomosis between the gall-bladder and the stomach or the duodenum so that a portion of the gall-bladder traverses the thickness of the anterior wall of the stomach (or duodenum) similar to the Schnitzler type of gastrostomy (Roeder technic, Spivack technic).

FIG. 274. Cholecystogastrostomy by the Spivack method. A portion of the gall-bladder is placed in the thickness of the stomach-wall.

c. To make an anastomosis between the gall-bladder and the common bile-duct (Wolff-Pribram cholecysto-choledochostomy).

CHOLECYSTO-DUODENOSTOMY BY THE LAMBRET METHOD

Step 1. A seromuscular continuous suture is made between the inferior surface of the gall-bladder and the anterolateral surface of the duodenum.

If it is difficult to place them in this manner without tension then the duodenum should be mobilized by the Kocher method.

Step 2. The gall-bladder is placed on the anterior wall of the duodenum and an anastomosis is made between the apex of the fundus and the innermost part of the anterior surface of the duodenum.

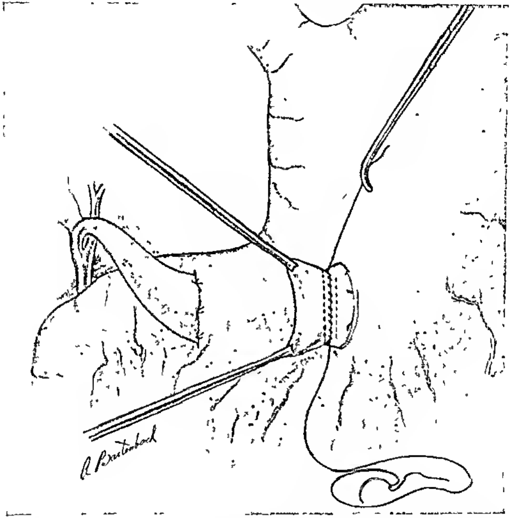

FIG 275. Cholecystogastrostomy by the Spivack method. Anastomosis between the stomach and the gall-bladder is begun

Step 3. The portion of the gall-bladder which lies on the anterior wall of the duodenum is covered by the duodenal wall by making a series of interrupted or continuous sutures so as to form some kind of a Witzel channel, with the exception of the place where the stoma is made.

Thus, the contents of the gall-bladder escape into the duodenum or

into the stomach and the contents of the stomach or of the duodenum will not run in an opposite direction

CHOLECYSTO GASTROSTOMY BY THE SPIVACK METHOD

Step 1 A seromuscular incision is made on the antrum of the stomach

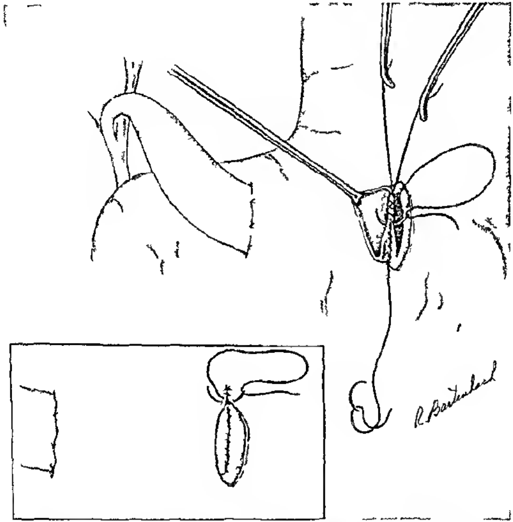

FIG 276 Cholecystogastrostomy by the Spivack method *Main picture*—Suturing the mucosa of the stomach to the entire thickness of the gall bladder wall *Insert*—Suturing the lips of the stomach wall to each other over the line of anastomosis

very close to the pylorus (Fig 274) Another seromuscular incision is made on the stomach one and a half inches proximal from the first and the seromuscular layer of the wall of the stomach between these two incisions is undermined The fundus (and if necessary a portion of the body) of the gall bladder is drawn through this seromuscular channel

(Fig. 274). A seromuscular suture is made between the anterior lip of the distal incision of the stomach (that is, the one lying closer to the pylorus) and the gall-bladder (Fig. 275).

Step 2. The cone of the gall-bladder is incised as is also the mucosa of the stomach. An anastomosis is made between these two structures (Fig. 276), suturing the mucosa of the stomach to the entire thickness of the wall of the gall-bladder.

Step 3. The seromuscular lips of the stomach are sutured to each other, thus covering the site of the anastomosis between the gall-bladder and the stomach (Fig. 276, insert).

In this way, the gall-bladder traverses the thickness of the stomach-wall approximately in the same manner as the common bile-duct traverses the wall of the duodenum, and this prevents regurgitation of the gastric or of the duodenal contents into the biliary tract.

CHOLECYSTO-CHOLEDOCHOSTOMY BY THE WOLFF-PRIBRAM METHOD (FIG. 277)

Step 1. The gall-bladder and the common bile-duct are well exposed. The neck of the gall-bladder is opened for a length of an inch, and all stones, if they are present, are removed from the gall-bladder. The common bile-duct is incised for an inch, and a lateral anastomosis is performed between the opening of the gall-bladder and that of the common bile-duct by one layer of interrupted buttonhole or mattress-sutures (Fig. 277). This layer is reinforced by covering it with the gastro-hepatic ligament.

This operation has the merit of giving good drainage of the gall-bladder without bringing it in direct communication with the alimentary tract. However, the disadvantage of this method lies in the technical difficulties, since the common bile-duct is narrow, unless it has had large stones in its lumen at some previous time.

Cholecysto-jejunostomy is performed in the same manner as a cholecysto-gastrostomy. Whenever the cholecysto-gastrostomy can be performed, it should be given the preference to cholecysto-jejunostomy.

b. Indirect Anastomosis between the Biliary and the Gastro-intestinal Tracts.

An indirect anastomosis is done only in those cases in which the direct anastomosis is impossible. This was first performed by Jenckel, in 1905, and published in 1910. He inserted one end of a rubber tube into the end of the divided hepatic duct and the other end into the lumen of the duodenum. Before entering the lumen of the duodenum, the rubber tube traversed for some distance the wall of the duodenum in a channel formed according to the Witzel type.

Sullivan, in 1909, published a report of his experiments on dogs. He

performed a series of choledocho duodenostomies in the same manner as just described (his report appeared before Jenckel published his report) The difference between Sullivan s and Jenckel s methods was that Sullivan did not perform a secondary operation for the removal of the rubber tube (which Jenckel did) but waited for the tube to pass into the duodenum

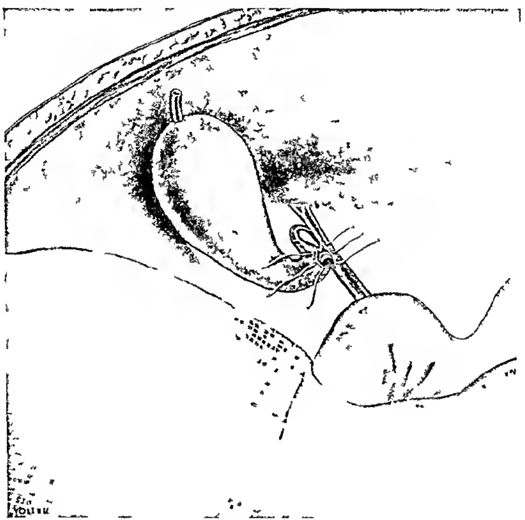

Fig 277 Cholecysto-choledochostomy (Wolff Pribram method)

which actually took place in his experiments Sullivan advised wrapping the rubber tube with traumatized omentum (Fig 278)

The early and late results of this operation are unsatisfactory For this reason, indirect hepato-duodenostomy or choledocho-duodenostomy should be used only in those cases in which a direct anastomosis is impossible

3. Direct anastomosis between the liver-parenchyma and some portion of the gastro-intestinal tract (Hepatocholangio-gastrostomy and Hepatocholangio-enterostomy).

This consists in suturing the lips of the opened wall of the stomach or bowel to the lips of the incised capsule of the liver, thus establishing a

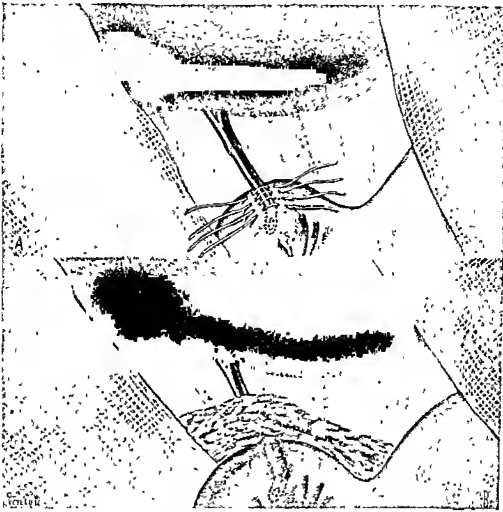

FIG. 278 Indirect method of choledocho-duodenostomy or hepato-duodenostomy (Jenckel-Sullivan method).

direct communication between the substance of the liver and the lumen of the gastro-intestinal tract. This operation was first suggested by Langenbuch, in 1897, and carried out by Kehr, Maylard, Garré and others. The results are very unsatisfactory and for this reason this method should never be resorted to.

4. Implantation of an existing external biliary fistula into the gastro-intestinal tract, or the artificial formation of an external biliary fistula

with its subsequent implantation into some hollow viscus of the gastro-intestinal tract.

a. Direct Implantation.

Czerny was the first who implanted, in 1902, an external biliary fistula into the alimentary tract. Since that time several cases have been reported in which an external biliary fistula has been implanted into the stomach, duodenum, jejunum, and even into the common bile-duct. The results of direct implantation of an external biliary fistula into the alimentary tract are excellent.

b. Indirect Implantation.

This consists in placing one end of a rubber tube into the distal end of the biliary fistula and the other end into the stomach or small bowel. Before this end of the rubber tube enters the lumen of the stomach or of the bowel it lies in a channel made of the anterior wall of the viscus in the form of a Witzel channel The results of indirect implantation are not good.

It appears a promising procedure to form as the first stage an external biliary fistula, and as the second stage to implant this fistula into the stomach or bowel or the common bile-duct.

CONCLUSIONS

Among the numerous methods of repair of the biliary passages, the best is the direct suturing of the ends of the divided common bile-duct. The next best is direct anastomosis between the gall-bladder and the gastro-intestinal tract. Indirect anastomosis in general is not satisfactory, and should be done only when the previously mentioned satisfactory methods are difficult to employ.

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CHAPTER XXI

SURGERY OF THE LIVER

I ROUTES FOR EXPOSURE OF THE INFERIOR ANTERIOR SUPERIOR AND POSTERIOR SURFACES OF THE LIVER

Different incisions are used for this purpose depending upon which surface is to be approached

a Approach to the Inferior and Anterior Surfaces

For approaching these surfaces various abdominal incisions are used such as those of Courvoisier, Kausch, Mayo Robson, Bevan, Kehr, Langenbuch, Kocher, Konig Perthes, Czerny Perthes, Don, Pochhamer and others which were described in Chapter II

b Approach to the Superior Surface

This was described in Chapter II

c Approach to the Posterior Surface

This was described in Chapter II

II SUTURE OF THE LIVER

Suture of the liver is used for the purpose of

A Checking hemorrhage

B Partial hepatectomy

A CHECKING HEMORRHAGE

In case of a hemorrhage from the liver two important tasks confront the surgeon

a He should prevent the occurrence of a sudden gush of blood from the injured liver after the abdomen is opened

b He should permanently control the bleeding after the abdomen is opened

a When hemorrhage of the liver occurs the blood fills the abdominal cavity and acts as a tampon, which compresses the liver and finally checks the hemorrhage As soon as the abdomen is opened, this pressure disappears and profuse bleeding may ensue For this reason as soon as the abdomen is opened a finger is immediately introduced into the foramen of Winslow and its anterior wall is grasped between the index finger and the thumb, thus compressing the hepatic artery and the portal vein (method of Hogarth Pringle) In order to have enough room in the operative field it is advisable to replace the fingers in the foramen of Winslow by blood-vessel forceps These forceps should not crush either the intima of the blood vessels or the endothelial lining of the common bile-duct The Spivack clamp serves this purpose After the clamps are applied the blood

is sponged out and the operative field becomes clear. Now it is necessary to use some measure to permanently check the bleeding.

b. Permanent control of the bleeding.

Different procedures are used to accomplish this. Of all the methods employed, three are most commonly used, namely, suturing, packing, and a combination of packing and suturing of the wound. It is best to pack the wound with iodoform-gauze and to suture the Glisson capsule over it, and then to bring the gauze out of the abdominal cavity. This method was very much recommended by M. Kousnetzoff and J. Pensky.

B. RESECTION OF THE LIVER

Historical

The liver was considered as a "noli me tangere" ("do not touch me") organ until 1870, when Bruns removed a portion of the liver in a soldier wounded in the Franco-Prussian war. In the later eighties he performed a partial hepatectomy for echinococcosis of the liver, and also for a case of carcinoma of the liver. He cut with the cautery, thus checking the hemorrhage, but if this persisted he tied the individual blood-vessels with silk ligatures. Lins, of Germany, removed a solid tumor from the liver in 1887. In Italy the first resection of the liver was performed by Loreta for echinococcosis of the liver, and published in 1888. König, in 1889, in Germany, and Keen, in the United States, in 1891, resected a portion of the liver. Hochenegg, in 1890, removed a portion of the liver for carcinoma, and being unable to suture the hepatic lips to each other, he sutured the lips of the Glisson's capsule of the liver to the peritoneum (thus being the first who produced a marsupialisation of the liver). and paced the wound with iodoform-gauze. However, all these cases of resection of the liver were rather sporadic.

The technic of resection of the liver was placed on a firm basis after Michael Kousnetzoff and Julius Pensky, both from the surgical clinic of Prof. Grube, of Kharkoff, published the results of their experiments in the St. Petersburg Surgical Review, in 1896. They performed their experiments on dogs and rabbits, and Mikulicz applied their method to the human with good results. Their conclusions were as follows:

1. A ligature of the liver tied slightly does not guarantee sufficiently against primary and secondary hemorrhage. In order to check the hemorrhage completely, the ligature should be tied very snugly.

2. The stump of the liver should be left in the peritoneal cavity and should not be extraperitonized.

3. The use of blunt needles prevents pricking of the wall of the intrahepatic blood-vessels, and, therefore, only blunt needles should be used for suturing the liver.

4 The application of ligatures to isolated hepatic blood-vessels is possible, since the walls of these blood-vessels offer great resistance

This method actually solved the problem of hemorrhage and made possible resection of the liver.

Later, other surgeons modified the technic of suturing of the liver, however, the essential elements are the same as those of the original Kousnetzoff and Pensky method

1 KOUSNETZOFF AND PENSKY METHOD

Straight and curved needles with blunt points are used For suture-material, heavy silk No 5 is used The technic, as described by these surgeons is as follows

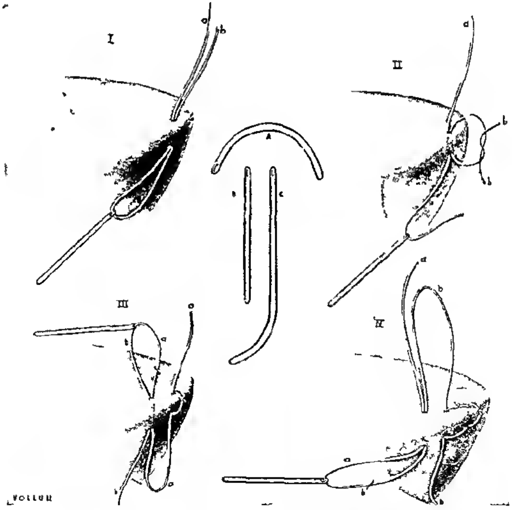

Fig 279 Suturing of the liver (Kousnetzoff Pensky method)

The needle, threaded with a double silk thread, enters on the upper surface, about 1 cm. away from the plane in which the liver will be cut, and reappears on the lower surface. Thus, the free ends of the thread are situated on the upper surface, and the needle with two threads is seen on the lower surface. The thread b is cut, close to the eye of the needle (Fig. 279, I), and the ends of the thread b are tied to each other (Fig. 279, II). The remaining part of thread b on the lower surface is made longer by traction. This is done at the expense of the thread a on the upper surface. This traction is continued until thread a on the upper surface is only about 5 cm. long. Then the needle is passed through the liver from below upward. Thread a is cut on the upper surface close to the eye of the needle (Fig. 279, III). The two free ends of thread a are tied to each other on the upper surface. Thread a is drawn away from the eye of the needle so as to make thread b on the lower surface only about 5 cm. long, and the needle is then passed from the upper to the lower surface of the liver. This procedure is repeated as often as necessary (Fig. 279, IV). [As may be seen, two threads are passing continually through the thickness of the liver, one compressing the tissue to the left and the other to the right.] The ends of the thread should be tied gradually and very tightly, so that they crush the liver-parenchyma and compress the vessels. After this "mass ligature," is completed, the liver should be resected 1 cm. distal from the suture-line. Usually, after tight ligation there is no bleeding from the individual vessels. However, if any individual blood-vessel bleeds it should be caught by an arterial clamp and ligated.

Kousnetzoff and Pensky demonstrated definitely that the blood-vessels of the liver are not more friable than those of any other organ.

2. AUVRAY MODIFICATION OF THE KOUSNETZOFF-PENSKY "MASSIVE LIGATURE METHOD"

This method was described by Maurice Auvray, of the Terrier clinic of Paris, in 1897. It consists of a series of mattress-sutures, which resemble the Kousnetzoff and Pensky suture, from which they differ only in the method of application. Auvray used a specially-constructed needle, which is a combination of a Reverdin and an Emmet needle (Fig. 280). He used two silk sutures No. 5; the length of each thread was from twenty-five to thirty cm. His technic was as follows:

The threads, lying very close to each other, penetrate the liver from the upper surface to the lower. The ends of each thread intertwine with each other so that each lies within the loop of the other (Fig. 280, I). The Auvray needle passes from the upper surface to the lower. Thread B is passed through the eye of the needle and brought out on the upper surface of the liver. Thread A is slowly and gradually tied by one knot with thread B on the upper surface of the liver, until the parenchyma

of the liver between O and O′ is crushed. Then the second knot is made (Fig. 280, II). The Auvray needle is then passed from below upward in the furrow produced by the crushed parenchyma of the liver. Thread B is passed through the eye of the needle and brought out on the lower surface of the liver. The Auvray needle penetrates the liver from the upper

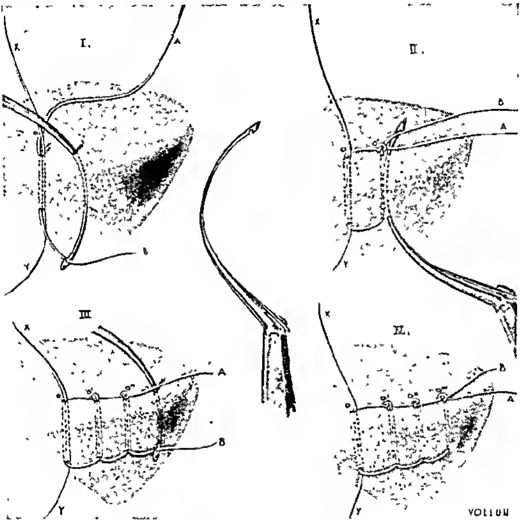

FIG. 280. Suturing of the liver (Auvray method).

surface to the lower at point O″, a distance of 1 cm. away from O′. Thread B is passed through the eye of the needle and is brought out on the upper surface of the liver. The ends of threads A and B are tied to each other gradually and snugly, so that the liver is crushed between the points O′ and O″, and then the second knot is made. This maneuvre is repeated as often as necessary (Fig. 280, III, IV). The same procedure is done with thread XY in the opposite direction. After the suturing is completed, the

liver is resected, and if there are any bleeding vessels they should be caught individually by artery-forceps.

3. HOUGH METHOD

This is performed as follows: A definite number of sutures are passed

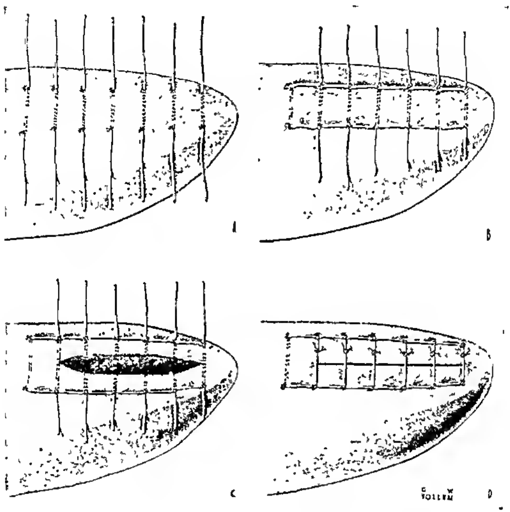

FIG. 281. Suturing of the liver (Hough method).

from one surface of the liver to the other. The free ends on the upper surface are tied to each other successively, that is, the first thread to the second, then one free end of the knot of the second thread is tied to the third thread, etc., so that actually a continuous buttonhole suture is formed on the upper surface of the liver. The same procedure is done on the lower surface. After that the portion of the liver lying to the periphery of these button-hole sutures is excised and one of the free ends of each knot on the

upper surface is tied to the corresponding free end of each knot of the lower surface After all the knots are tied the picture will be as shown in Fig 281

As may be seen, there will be knots on the upper surface and on the lower surface, and also knots produced by tying the strands of the upper surface of the liver to the strands of the lower surface of the liver This is an excellent method of suturing, and we believe it is much simpler than any other method described

III OPERATIONS FOR ABSCESS OF THE LIVER

Of the different types of abscess of the liver the amebic form is that most frequently met with The amebic abscess may be either single or multiple It is not always treated surgically In some cases the *intramuscular injection of* emetine *hydrochloride followed by the oral adminis*tration of ipecacuanha, gives excellent results The surgical treatment may be as follows

a Aspiration of the abscess
b Incision and drainage of the abscess

a Aspiration of the abscess

This consists in emptying the abscess once or, if necessary, repeatedly, with it without washing out the cavity by some antiseptic fluid, such as Dakin's solution Although, generally such "closed methods" are considered non surgical, nevertheless, experience shows that this method has reduced the mortality from 50 per cent to 5 per cent, and it should be considered as a method of choice

The objection to the "closed method" lies in the supposed danger of secondary infection However, this is groundless, since from 80 to 90 per cent of all amebic abscesses contain sterile pus, and the *endamoeba histolytica* is embedded in the wall of the abscess activity

Aspiration is done by means of a large-caliber needle connected with a large glass syringe or by a Potain aspirator The needle may be attached to a rubber tube which is connected with any kind of a suction apparatus It is not advisable to wash out the emptied cavity with an antiseptic solution This surgical intervention should always be followed by an intramuscular injection of emetine (0 06 gm of emetine for the first 6 days, 0 03 gm of emetine for the following 4 days, and 0 06 gm of emetine once a week for 4 more weeks, always intramuscularly and followed by the oral administration of ipecacuanha)

b Incision and drainage of the abscess

This method carries a great risk of secondary infection, and for this reason it is indicated *only under definite conditions*, as follows

1. Cases in which aspiration and emetine have not given relief.

2. In case the abscess is located in the left lobe of the liver (this occurs only in 20 per cent of all cases; in 80 per cent it is localized in the right lobe of the liver), when aspiration carries some dangers of injury to the large blood-vessels.

3. In case the abscess has ruptured into the pleural or peritoneal cavity.

Technic.

Step 1. The incision depends upon the location of the abscess. In the majority of cases the abscess is located on the postero-superior surface of the liver. Therefore, a right side abdominal or thoraco-abdominal incision with resection of one or two ribs will be sufficient. [Extreme care should be taken in case of a rib-resection not to open the pleural cavity.]

Step 2. The parietal peritoneum is sutured to the capsule of the liver at a distance of an inch and a half from the abscess. If it cannot be sutured all the way circularly, then the peritoneal cavity should be "walled off" from the abscess and not sutured at all.

Step 3. The liver-substance is opened over the abscess by diathermy and the pus evacuated. A finger is introduced into the cavity to discover whether any other abscess-cavities are present. Some surgeons advise scraping of the wall of the abscess, since the *endamoebae histoliticae* are usually situated in the wall. However, many surgeons, highly authoritative on the subject of surgery of tropical diseases, do not advise scraping, but are using emetin intramuscularly postoperatively. A rubber tube is placed in the cavity.

IV. SURGICAL TREATMENT OF ECHINOCOCCUS OF THE LIVER

The various operative procedures as practised to-day can be divided into three groups:

1. Resection of the portion of the liver which contains the echinococcus.
2. Incision of the hydatid cyst with drainage in one or two stages.
3. Enucleation of the cyst.

1. Resection of the portion of the liver containing the cyst.

This is an ideal method. It became possible only after suture of the liver had been placed on a safe basis. However, it is not always possible to employ this method on account of the inaccessibility of the cyst. The technic of its execution is exactly as described in "Resection of the liver."

2. Incision of the hydatid cyst with drainage in one or two stages.

a. One Stage Method.

Step 1. The abdomen is opened in the manner described previously for exposure of the liver.

Step 2 *The cyst is "walled off" from the rest of the peritoneal cavity* The abdominal wall should be carefully protected from a possible contamination by the contents of the cyst The fluid is carefully aspirated, and 300 to 400 c cm of one per cent solution of formol is injected into the cystic cavity and kept there for five minutes to kill the scolices (suggestion of *Quénu and Dévé*)

Step 3 A one inch incision is made through the liver tissue and the wall of the cyst Each lip of the wall of the cyst is cought by an Allis forceps A suction apparatus is introduced to aspirate the formol The incision is then enlarged A finger is introduced into the cavity for its *examination, daughter cysts may bulge into the cavity If so, they should* be broken by the finger

Step 4 The endocyst is caught by a forceps and gently drown out The entire endocyst should be removed

Step 5 The cavity is packed with gauze The lips of the incised wall of the cyst are sutured to the parietal peritoneum, the posterior sheath of the rectus muscle, and to the entire thickness of the muscle The laparotomy pads, which were "walling off" the peritoneal cavity from the cyst, are removed gradually while the liver is sutured to the anterior abdominal wall

Step 6 The pack in the cavity of the cyst is removed and replaced by a rubber tube and gauze

Step 7 The abdomen is closed in layers with the exception of the portion through which the gauze projects

b Two Stage Operation

First Stage

Step 1 The abdomen is opened as in the previous operation As an additional precaution it is advisable to "wall off" the cyst from the peritoneal cavity and to protect the anterior abdominal wall, just as in the previous operation

Step 2 The liver around the cyst is sutured to the parietal peritoneum The wound is packed with gauze

Step 3 The abdomen is closed

Four days later the second stage is performed

Second Stage

Step 1 The abdomen is reopened through the original incision

Step 2 The contents of the cyst are aspirated, 300 to 400 c cm of a one per cent solution of formol is introduced into the cavity The cyst is incised after the formol solution has been there for five minutes The endocyst is removed A rubber drain wrapped in gauze is placed in the cavity of the cyst, and is brought outside of the abdominal cavity

Step 3. The abdominal wall is closed.

Some surgeons prefer the "one stage method" to the "two stage method," and others *vice versa*. Moynihan gives preference to the one stage method because it gives more room for the operation, and in case of careful "walling off" of the cyst from the rest of the peritoneal cavity the danger of contamination is slight.

3. Enucleation of a Hydatid Cyst.

This consists in a complete enucleation of the cyst with blind closure of the regular liver-gap, and closure of the abdomen without drainage. The first enucleation was performed by Knowsley Thornton, in 1883. However, he removed the endocyst only. In France, this method is known as the "Delbet operation." However, Delbet performed it the first time only in 1895. The priority, therefore, belongs to Knowsley Thornton. In Russia and in the rest of Continental Europe, with the exception of France, it is known as the "Bobrow method." However, Bobrow described it only in 1898. J. P. Buckley, in 1913, described a total enucleation in which not only the endocyst but also the ectocyst was removed.

The enucleation method should be employed only for "clean cases," that is, those in which the contents of the sac have not suppurated. For suppurative cases, the "incision and drainage method" as a one or two stage operation should be employed.

Step 1. The abdomen is opened. The area around the cyst is "walled off" from the rest of the peritoneal cavity.

Step 2. The contents of the cyst are aspirated; 300 to 400 c.cm., of a one per cent solution of formol are injected. Five minutes later, the cyst is incised and the contents evacuated.

Step 3. An artery-clamp grasps the endocyst and removes it from the ectocyst. [Many surgeons, who are very competent in this particular field of surgery, do not consider it important to remove the ectocystic wall.]

Step 4. Several sutures are passed within the cavity of the cyst catching the ectocystic wall on one side and suturing it to the opposite wall, thus eliminating the "dead spaces."

Step 5. The edges of the incised liver are sutured to each other.

Step 6. The abdominal wall is closed in layers without drainage.

V. OPERATIONS FOR ASCITES DUE TO CIRRHOSIS OF THE LIVER

The numerous operations which are used for drainage of ascites due to cirrhosis of the liver may be classed in two groups:

A. Operations which diminish the flow of blood to the obstructed portal vein.

B. Operations which drain directly or indirectly the ascitic fluid.

A OPERATIONS WHICH DIMINISH THE FLOW OF BLOOD TO THE OBSTRUCTED PORTAL VEIN

As is well known, the portal and systemic venous systems have a definite anastomosis with each other, namely

a Between a vein in the round ligament of the liver, which is a tributary of the left branch of the portal vein, and the superior epigastric vein of the anterior abdominal wall

b Between the left gastric and both azygos veins through the esophageal plexus

c Between the inferior mesenteric and the internal iliac vein by means of the middle and inferior hemorrhoidal plexuses

d Between the pancreatic and the lumbar veins

These normal connections become greatly exaggerated in the case of portal obstruction The aim of all the operations of this group is to increase these vascular connections by forming adhesions between the abdominal viscera, which drain the blood into the portal vein and the abdominal parieties, which drain the blood into the venæ cavæ (superior and inferior), or to make a direct anastomosis between the large veins of the portal and systemic system, such as between the inferior vena cava and the vena porta (**Eck fistula**), or between the inferior vena cava and the superior mesenteric vein (**Bogoras operation**)

The vascular connections between the systemic and portal systems are increased by forming adhesions

a Between the omentum and the anterior abdominal wall

b Between the liver and the spleen with the vault of the diaphragm or the anterior abdominal wall

c Between the gall bladder, or even the bowel, and the anterior abdominal wall

a FIRST TALMA OPERATION (DRUMMOND MORISON OPERATION)

This operation was suggested by Talma in his course on "Pathology of the Liver," in the year 1887 It was first performed by Van der Meulen in 1889, and by Schelkly in 1891, in both cases at Talma's suggestion and published by Talma's student, Dr Th Lens, in 1892 It consisted in suturing the great omentum to the inner surface of the peritoneum (as done by Van der Meulen), or by supplementing this with suturing of the gall bladder to the anterior abdominal wall (operated so by Von Eiselsberg at the suggestion of Talma on March 7th, 1896), or by placing the spleen in front of the rectus muscle between it and the skin in the sac thus formed (operated in this way by Narath at the suggestion of Talma, on July 2nd, 1896) Talma himself had his first opportunity of operating for ascites only in 1898 David Drummond and Rutherford Morison performed this operation on Sept 3rd, 1894, and on October 22nd, 1895,

prior to their publication of the method on Sept. 19th, 1896. However, to Talma and his pupils belong the priority both in performing and in publishing the method.

Technic.

Step 1. The abdomen is opened. The fluid is evacuated very slowly

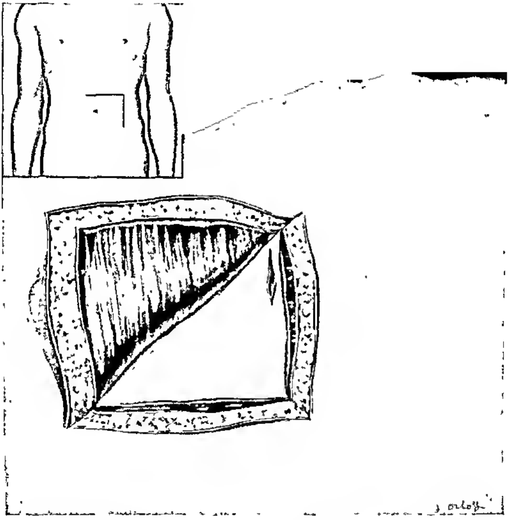

FIG. 282. Surgical treatment of ascites (Schiassi modification of the Talma operation). *Insert*—Skin-incision viewed from the front. *Main picture*—The flap is reflected (view from the left side).

until the abdominal cavity is dry. The diaphragmatic surfaces of the liver and spleen are vigorously scrubbed with gauze. The peritoneal surface of the diaphragm lying opposite the scrubbed surfaces of the liver and spleen are also scrubbed with gauze.

Step 2. The omentum is sutured either to the inner surface of the

parietal peritoneum, or is placed in a sac formed between the outer surface of the peritoneum and either the posterior sheath of the rectus muscle or the rectus muscle itself.

Step 3. The abdomen is closed.

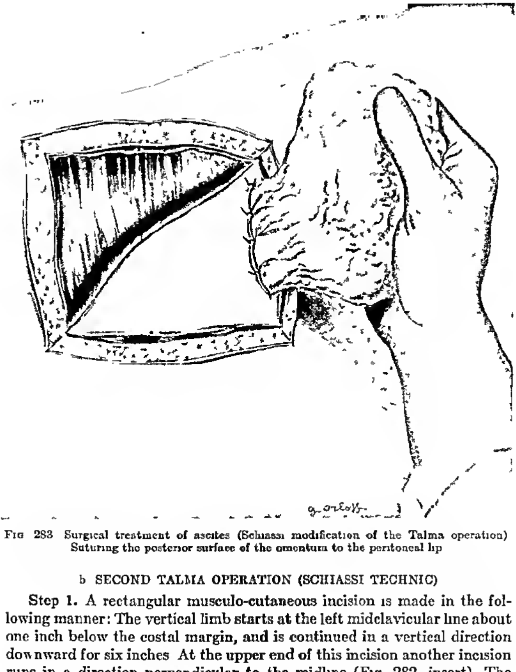

FIG 283 Surgical treatment of ascites (Schiassi modification of the Talma operation) Suturing the posterior surface of the omentum to the peritoneal lip

b SECOND TALMA OPERATION (SCHIASSI TECHNIC)

Step 1. A rectangular musculo-cutaneous incision is made in the following manner: The vertical limb starts at the left midclavicular line about one inch below the costal margin, and is continued in a vertical direction downward for six inches At the upper end of this incision another incision runs in a direction perpendicular to the midline (Fig. 282, insert). The abdominal wall is incised down to the peritoneum. Thus, the rectus muscle

is split longitudinally in one direction and cut transversely in another direction. The musculo-cutaneous flap is reflected to its base (Fig. 282).

Step 2. A small opening is made in the peritoneum at the medial end of the transverse incision and the fluid is gradually evacuated (Fig. 282). The transverse opening of the peritoneum is enlarged laterally for two-

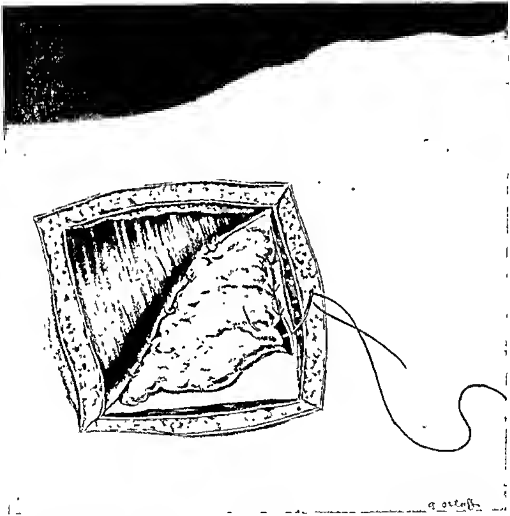

FIG 284 Surgical treatment of ascites (Schiassi modification of the Talma operation). Suturing of the anterior surface of the omentum to the peritoneal lip. The edge of the omentum is already sutured to the base of the musculo-cutaneous flap.

thirds of the length of this horizontal incision. The omentum is drawn outside until it entirely covers the exposed peritoneum. The omentum is lifted and its posterior surface is sutured by interrupted sutures to the inferior lip of the peritoneum (Fig. 283). The upper surface of the omentum is sewed to the superior lip of the transverse peritoneal incision (Fig. 284).

The free margin of the omentum is sutured to the peritoneum along the base of the musculo-cutaneous flap (Fig. 284).

Step 3. A vertical incision is made through the peritoneum to the left of the lateral end of the transverse peritoneal incision (Fig. 285). The length of this incision is about five inches. The spleen is brought into

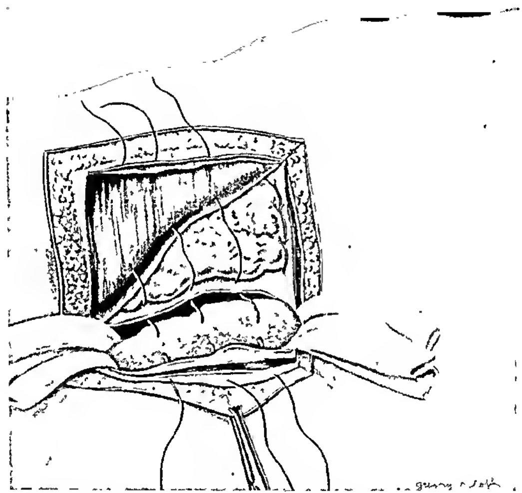

FIG 285 Surgical treatment of ascites (Schiassi modification of the Talma operation) A splenopexy is done

the wound. A roll of gauze is introduced into the abdominal cavity and placed between the upper pole of the spleen and the diaphragm. The free end of this gauze is brought outside of the abdominal cavity. Another roll of gauze is placed between the lower pole of the spleen and the diaphragm and its free end is also brought outside the abdominal cavity through the lower end of the incision (Fig. 285).

Step 4. Fixation of the spleen to the anterior abdominal wall.

A large curved needle, threaded with catgut No. 5, penetrates the entire thickness except the skin of the left lip of the anterior abdominal wall, two inches away from the opening. Then it passes through the capsule of the spleen including some of its parenchyma. Then it runs in an opposite

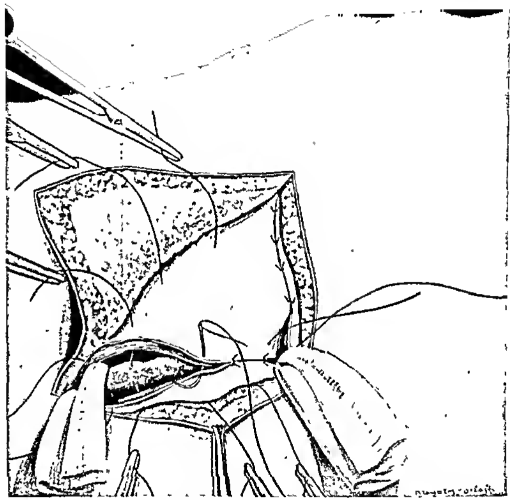

FIG. 286. Surgical treatment of ascites (Schiassi modification of the Talma operation). Suturing the anterior abdominal wall.

direction, grasping the peritoneum and the entire thickness of the musculocutaneous flap, with the exception of the skin (Fig. 285). These sutures are placed at a distance of one and a half inches apart. The number of sutures depends on the size of the spleen. These sutures are not tied at this time. [Instead of penetrating the entire thickness of the abdominal wall, these transfixing sutures may grasp the peritoneum and the transversalis fascia only.]

Step 5 Suturing of the anterior abdominal wall in layers (Fig 286) The peritoneum, with the posterior sheath of the rectus muscle the muscle itself, and the anterior sheath, are sutured in layers, leaving untied sutures only at the upper and lower ends of the incision where the gauze makes its exit from the abdominal cavity Then the sutures which fix the spleen to the anterior abdominal wall are tied The skin sutures are now inserted, leaving again a few skin sutures untied at the place of exit of the gauze rolls A few days later, when the gauze is removed, all the untied sutures at the upper and lower end of the incision are tied

c SECOND TALMA OPERATION (NARATH TECHNIC)

This is an omentopexy supplemented by a splenopexy in which the spleen is placed in front of the left rectus muscle

Step 1 As Step 1 of the *previous operation*

Step 2 The skin and superficial fascia are retracted from the anterior sheath of the left rectus muscle so that a sac is formed The omentum and spleen are brought outside of the abdominal cavity and placed in the sac

Step 3 The abdomen is closed, care being taken not to compress the omentum or the pedicle of the spleen (the gastro splenic ligament)

This operation differs from the Schiassi operation in this respect only that Narath places the omentum and spleen in front of the rectus muscle whereas, in the Schiassi method the omentum is placed behind the rectus muscle and the spleen remains in the abdominal cavity

d **Splenectomy** is used by some surgeons for the purpose of diminishing the degree of obstruction of the portal vein with or without the Talma operation

If the spleen is normal in size about one seventh of the blood of the portal vein is contributed by the splenic vein The larger the spleen becomes (and its enlargement is a rule in cases of cirrhosis of the liver in which ascites develops), the more the splenic vein contributes to the portal vein, and in very large spleens the blood of the splenic vein may constitute half of the amount of the blood supply of the portal vein For this reason, splenectomy deprives the portal vein of a very important tributary However, splenopexy is far less dangerous, particularly in weakened patients, than splenectomy, and gives no worse results Therefore, it should be given preference to splenectomy

e DIRECT ANASTOMOSIS BETWEEN THE PORTAL VEIN AND THE INFERIOR VENA CAVA (ECK FISTULA)

This operation has been performed a number of times, but several objections have been raised against its use

1 It is hazardous to sidetrack the entire blood of the portal vein,

which carries all the blood of the small and large bowels with their toxins, without the benefit of the filtrating and detoxicating influences of the liver.

2. The technical difficulties of its execution.

We believe that this operation will probably never be of great appeal to the surgeon.

f. IMPLANTATION OF THE SUPERIOR MESENTERIC VEIN INTO THE INFERIOR VENA CAVA (BOGORAS OPERATION)

This was first performed in 1912 and published in January, 1913, by N. A. Bogoras, of Tomsk, Russia. The superior mesenteric vein is cut at the lower end of the meso-ileum and its distal (aboral) end is implanted into the vena cava inferior.

Technic.

Step 1. Abdominal section through a right pararectus incision six inches in length which starts three inches above the level of the umbilicus.

Step 2. The ascitic fluid is drained. The terminal portion of the ileum is drawn outside the abdominal cavity and the terminal meso-ileum is exposed. The superior mesenteric vein in this locality is exposed. It is easy to find this because it lies close to the artery which can be seen or felt pulsating. The vein is exposed for a distance of about two inches. A ligature is applied to the proximal end of the exposed vein, care being taken to leave several veins proximal to the point of ligation, so as not to divert the entire amount of blood of the small intestines from the portal circulation. A blood-vessel clamp is placed transversely on the superior mesenteric vein at a distance of about two inches distal from the ligature, and the vein is cut close to the ligature. The bowels are replaced and the vein hangs free upon the inferior surface of the meso-ileum.

Step 3. The parietal peritoneum of the posterior abdominal wall is cut in front of the inferior vena cava, the anterior wall of which is exposed for two inches. Part of the anterior wall is caught axially with an arterial non-crushing clamp. A small opening is made in the fold of the inferior vena cava. Four sutures, placed at equal distance from each other, unite the circumference of the open end of the superior mesenteric vein with the opening of the vena cava. These sutures penetrate the entire thickness of the wall of each blood-vessel. The ends are left long and are used as traction-sutures. A row of continuous sutures is placed between each two traction-sutures, care being taken not to produce a purse-string action.

Step 4. The edges of the incised parietal peritoneum of the posterior abdominal wall are resutured.

It should be mentioned that although this operation is technically difficult and can be done only by a skilful surgeon, nevertheless, it is easier

than one would think from observing the size of the superior mesenteric vein in the cadaver, since in the presence of portal obstruction all the intestinal veins become greatly enlarged. Several reports have been published in which this method was employed with gratifying results. However, we do not believe that this procedure will be frequently adopted.

In 1926, Flerow suggested a new method, which consists in the ligation of the left gastric artery, the right and left gastro-epiploic arteries, and the inferior mesenteric vein. The aim of this procedure is evident: By ligation of the several arteries carrying the blood-supply to the stomach, the veins of the stomach will receive their blood-supply mainly from the portal vein by a reverse flow of blood from this vein. By ligation of the inferior mesenteric vein, the amount of blood running to the portal vein is still further diminished, thus lessening the engorgement of that vein. Several cases have been reported in which this operation was performed with good results.

Recently, E. Holman suggested a new method of treatment of ascites due to hepatic cirrhosis, which consisted in the ligation of the splenic artery followed by splenopexy. The expectation is that the venous blood will, under such conditions, change its direction, and will flow from the portal vein into the splenic, thus diminishing the degree of obstruction.

However, in the only case reported the results were unsatisfactory. Further reports will be necessary before the value of this operation can be established. As may be seen, the Holman suggestion is based upon the Flerow principle.

B. OPERATIONS WHICH DRAIN THE ASCITIC FLUID DIRECTLY OR INDIRECTLY

Various procedures are employed for this purpose, of which we shall describe only a few:

a. ASPIRATION METHOD

This is the oldest and simplest method. Two complications may arise in performing it, namely, injury of a large blood-vessel of the anterior abdominal wall, and puncturing of a bowel with the possibility of peritonitis or the developing of a fecal fistula. However, the main objection to this method is that the fluid constantly accumulates, and puncture necessarily becomes a frequent procedure.

b. IMPLANTATION OF THE SAPHENOUS VEIN INTO THE PERITONEAL CAVITY (*RUOTTE OPERATION*)

This operation consists in the implantation of the great saphenous vein into the peritoneal cavity. The ascitic fluid runs into the saphenous vein and farther on into the femoral vein, thus entering the general blood circulation. The back-flow of blood from the femoral vein into the free peritoneal cavity is prevented by the valves in the vein which allow the blood or

any fluid to run in one direction and prevent it from running in the opposite direction. The operation was first performed by Ruotte, in 1907.

Technic.

Step 1. A skin-incision is made on the anterior surface of the thigh,

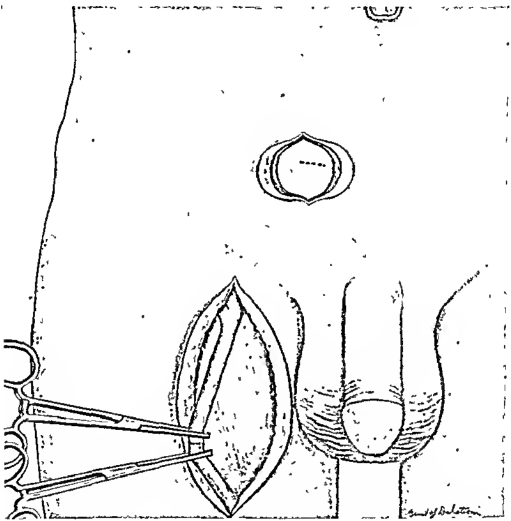

FIG. 287. Surgical treatment of ascites (Ruotte operation). Exposure and clamping of the great saphenous vein.

starting at a point three centimeters lateral to the pubic spine, and four centimeters below it. This incision is carried in a downward and slightly medial direction for a distance of ten centimeters. The long saphenous vein is exposed for the same distance from its mouth, and is cut at a distance of ten centimeters from the femoral vein. Its distal end is ligated (Fig. 287).

Step 2. The anterior wall of the abdomen is cut through its entire

thickness for a length of three centimeters slightly above the Poupart ligament. The peritoneum is cut for a length of two centimeters only (Fig. 288). The ascitic fluid is gradually withdrawn.

Step 3. A subcutaneous canal is formed between the upper and lower skin-incisions, and the portion of the saphenous vein which is connected

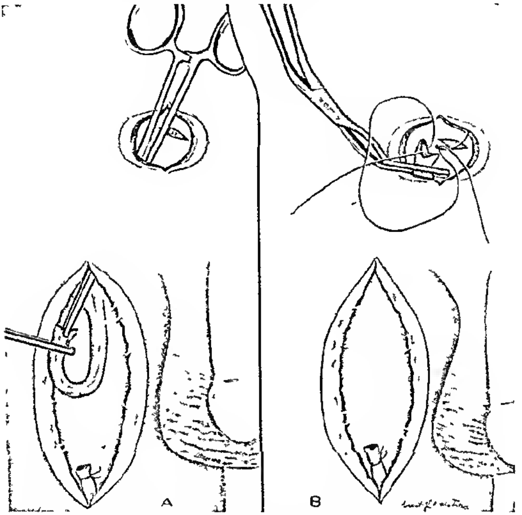

Fig 288 Surgical treatment of ascites (Ruotte operation) A The great saphenous vein is cut, its proximal end is caught and ready to be drawn through a subcutaneous canal B Suturing the great saphenous vein to the lip of the peritoneal opening

with the femoral vein is brought through it (Fig. 288, B). The edge of the vein is bevelled, and the lips of the opened peritoneum are sutured to the open end of this vein, thus forming an anastomosis between the peritoneal cavity and the venous sytem (Fig. 288, B).

Step 4. The wound is closed in the usual manner. No drain should be placed.

Several cases have been reported by different authors who have used this method. Most of the reports were commendatory. However, some cases are recorded in which either the anastomosis became occluded, or in which the entire portion of the saphenous vein between the femoral vein

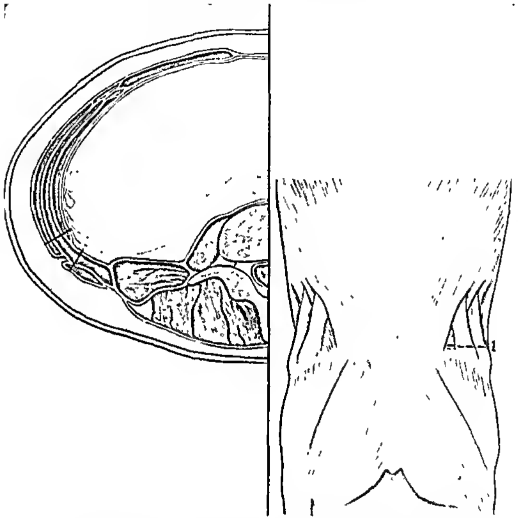

FIG. 289. Surgical treatment of ascites (Kalb operation) (See text.) 1 Petit triangle.

and the peritoneum became obliterated, so that it was necessary to resort to other methods for overcoming the ascites.

c. OPENING OF A NEW LYMPHATIC PATHWAY (KALB OPERATION) (FIG. 289)

This operation is based on the idea that the best method of handling the ascites is to drain it into the subcutaneous tissues. By this procedure two things will be accomplished; namely, the patient will not lose the

albuminous portion of the ascitic contents, which will be reabsorbed, and the ascitic fluid will disappear from the abdominal cavity

Technic

Step 1. Abdominal section is made through a midline incision extending from the umbilicus downward for 4 to 5 inches After the opening has been made the fluid is slowly evacuated

Step 2. An incision is made to the left of the sigmoid in the left lumbar region, and another to the right of the cecum in the right lumbar region, at the space which forms the Petit triangle The peritoneum and the muscles of these regions are excised (part of the latissimus dorsi medially, part of the external oblique muscle laterally, and part of the internal oblique and transversus abdominis muscles at the floor of the triangle) so that only the subcutaneous tissue and the skin are left intact The size of the excised portion is about that of a silver dollar

Step 3 The abdomen is closed in the usual manner

Several cases have been reported by different surgeons in which this technic has been used with good results

VI HEPATOPEXY

Definition.

This term consists of two Greek words ἧπαρ, liver and πηγνυναι to fasten It signifies "fastening of the liver"

Indications

A movable liver which has become partially or totally displaced from its bed

General Remarks

The first reported case of a movable liver was encountered by the great German anatomist Laurent Heister on the dissecting-table, in 1754 The *first hepatopexy for partial hepatoptosis* was performed by *Billroth*, in 1884, and for total hepatoptosis by Michl, of Prag, in 1887 To the latter is usually given the credit of being the first surgeon who performed hepatopexy In France, for many years the credit for priority has been erroneously given to Gérard-Marchant, who performed the operation for the first time only in 1891 He was preceded not only by Billroth and Michl but also by Tcherning, who performed hepatopexy for partial hepatoptosis in 1886, and by Langenbuch who performed this operation in 1890, for total hepatoptosis

The treatment depends on whether the hepatoptosis is partial or total [By partial hepatoptosis is understood a condition in which the upper surface of the liver has not lost its contact with the diaphragm The lower portion becomes enlarged, forms a flap, and this part actually becomes

movable and responsible for symptoms. Under the name of total hepatoptosis, or wandering liver, or hepar migrans, is understood a condition in which the liver has lost its contact with the diaphragm and does not lie in the right hypochondrium only, but descends and lies in the lumbar or even in the iliac region.] In the case of total hepatoptosis, the treatment is surgical only, while in the case of partial hepatoptosis medical treatment should be attempted at first. Surgery in the latter cases should be resorted to only after medical treatment has failed.

Numerous procedures have been suggested differing from each other in the position of the abdominal incision, in the method of fixation of the liver, in the use of different suture-material, in various types of needles employed, etc.

Abdominal Incisions in Hepatopexy.

Transverse incisions running below and parallel to the right costal arch are most frequently employed for this operation. However, longitudinal incisions, such as the midline, midrectus and right pararectus, are used quite frequently.

In many cases, a transverse incision starting at the lumbar region and reaching the midline is employed. As a matter of fact, this is the earliest type of incision, because the surgeons started the operation with an erroneous diagnosis of a movable kidney. Poppert used a flap incision of a "Λ" shape, the vertical part of which is a right pararectus incision and the oblique limb runs parallel to the right costal arch.

The suture-material used is silver-wire, catgut or silk. The needles which are used are either ordinary large curved needles, penetrating the tissue by the eye instead of the point, or specially devised needles of the type of Kousnetzoff and Pensky or Auvray. The depth of the bite through the liver-tissue also varies: Some surgeons (Bobrow) passed the thread through the entire thickness of the liver, others (Langenbuch, Gérard-Marchant) only through the entire thickness of the anterior edge of the liver, some advised piercing the liver only for a depth of 2 cm., etc.

METHODS OF FIXING THE LIVER IN ITS PROPER POSITION

The numerous methods described may be classed into several groups:

A. The formation of adhesions between the upper surface of the liver and the diaphragm or the parietal peritoneum of the anterior abdominal wall.

B. Anchoring of the liver to the anterior thoracic or abdominal wall by sutures.

C. Anchoring of the round ligament to the chest-wall or to the anterior abdominal wall.

D. Formation of a partition, either from the peritoneum or from the falciform ligament, which supports the liver and prevents its sliding from its bed into the lumbar or iliac region

E. Excision of a part of the anterior abdominal wall (laparectomy).

F. A combination of the above mentioned methods.

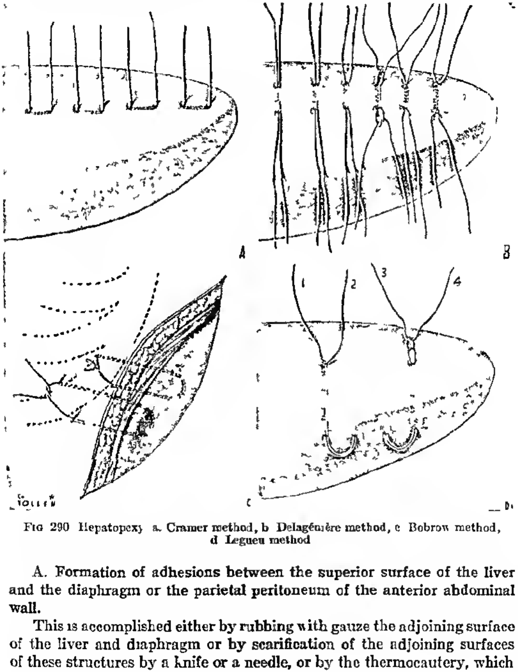

FIG 290 Hepatopexy a. Cramer method, b Delagénière method, c Bobrow method, d Legueu method

A. Formation of adhesions between the superior surface of the liver and the diaphragm or the parietal peritoneum of the anterior abdominal wall.

This is accomplished either by rubbing with gauze the adjoining surface of the liver and diaphragm or by scarification of the adjoining surfaces of these structures by a knife or a needle, or by the thermocautery, which is placed at some distance from the structures, or by inserting gauze

between the adjoining surfaces of the liver and diaphragm or the anterior abdominal wall, which is removed several days later.

B. Anchoring of the liver to the anterior thoracic or abdominal wall by sutures.

In this group of operations the mattress-sutures pass either through the entire thickness of the parenchyma of the liver or through the superficial layer only. The number of sutures varies from one to nine. The free ends are brought outside either through the abdominal wall or through the lower end of the chest-wall.

1. Cramer Method (Fig. 290, A).

Three or four silk sutures are inserted into the substance of the liver at a distance of 3 cm. from each other. The free ends are brought outside the anterior abdominal wall. The sutures are tied only after all have been inserted.

2. Delagénière Method (Fig. 290, B).

Six catgut double-threaded sutures are placed on the anterior surface of the liver parallel to each other and at a distance of one and one-half cm. from each other. At the sites of entrance and exit of each double thread, the individual thread is tied to its fellow. The knots so formed prevent hemorrhage from any tracks formed in the liver-parenchyma by the passage of the threads. The free ends of the threads are brought outside the *anterior abdominal* wall and tied *to each* other.

3. Bobrow Method (Fig. 290, C).

Two silk sutures penetrate the upper surface of the liver and are brought out through the chest-wall and fixed to the cartilage of the ninth rib.

4. Legueu Method (Fig. 290, D).

A Reverdin needle penetrates the liver from the lower to the upper surface and draws two threads from above downward. Then the sutures pass along the lower surface of the liver, care being taken not to include the gall-bladder in them. The Reverdin needle passes then from the upper surface of the liver to the lower and brings the threads from below upward. The ends of the thread 1, 2, 3, and 4 are brought outside either through the abdominal or chest-wall, and 1 is tied to 2 and 3 to 4.

C. Anchoring of the round ligament to the chest-wall or to the anterior abdominal wall.

1. Ramsay Technic.

The round ligament of the liver is fastened to the seventh rib, and in addition to this the parenchyma of the right lobe is sutured to the anterior abdominal wall.

2 Werelius Method (Figs 291, 292)

The abdomen is opened The superior surface of the liver and the corresponding surface of the diaphragm are rubbed with gauze so as to facilitate the formation of adhesions The chest-wall is punctured above the

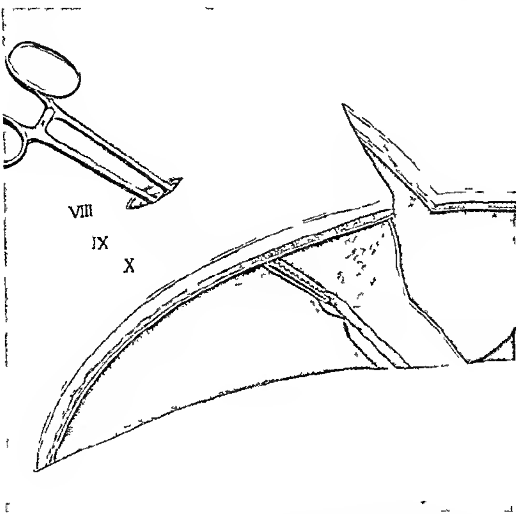

FIG 291 Hepatopexy (Werelius method) An artery clamp enters the abdominal cavity through the eighth intercostal space and grasps the round ligament

cartilage of the ninth rib The round ligament is brought through this opening outside the abdominal cavity onto the chest wall and hooked around this cartilage and then brought back into the abdominal cavity through another small incision below the cartilage of the ninth rib The two limbs of the round ligament which form a loop around the cartilage of the ninth rib are sutured to each other The abdomen is then closed

3. Grosz Method.

This is similar to the Werelius method with the difference only that the round ligament is cut across and the end of the proximal part is hooked around the cartilage of the ninth rib, as in the Werelius technic, and the two limbs are sutured to each other.

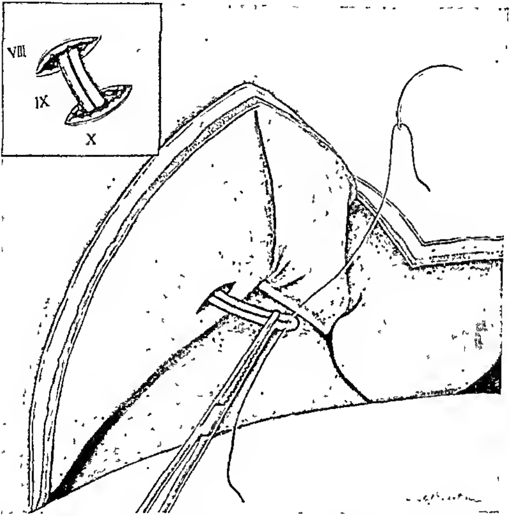

FIG 292. Hepatopexy (Werelius method). *Insert*—A portion of the round ligament is brought outside the abdominal cavity. *Main picture*—The round ligament is brought back into the abdomen and sutured to its beginning

D. Formation of a partition, either from the peritoneum or from the falciform ligament, which supports the liver and prevents its sliding from its bed into the lumbar or iliac region.

As fixation of the uterus from above is considered incomplete unless the perineum is strengthened from below by perineorrhaphy, some surgeons

consider that no matter how strongly the liver is immobilized from above, some kind of a partition should be built below the lower edge of the liver which will prevent it fron sliding downward

1 Pean Method

This method was suggested by Péan in June, 1896

Step 1 A transverse abdominal incision is made below the costal arch and reaches the umbilicus The liver is placed in its proper position The parietal peritoneum, with the transversalis fascia of the upper lip, are made mobile by separating them from the superficially situated muscles, and are sutured to the parietal peritoneum of the posterior abdominal wall, thus producing a partition which will prevent downward sliding of the liver

We believe that this method, supplemented by the artificial formation of adhesions between the liver and the diaphragm, and also by fixation of the liver by the aid of the round ligament, constitutes an excellent method of hepatopexy

2 Franke Method

This was described in 1895 A transverse incision is made parallel to and below the right costal arch The peritoneum and the transversalis fascia of the upper lip are mobilized from the superimposed muscles A series of sutures are passed which connect the anterior surface of the liver with the mobilized peritoneum and transversalis fascia and also the super imposed muscles of the upper lip, after which the knots are tied in front of the muscles That portion of the peritoneum of the upper lip between the sutures and its free edge is turned behind the liver and sutured to its posterior surface This method, with a slight modification was redescribed, in 1904, by A Depage and L Mayer of Brussels, and is known in France and Belgium as the Depage Mayer method However, priority belongs to Franke

3 Foderl-Kaiser Method (Fig 293)

This was published by Kaiser in 1922 The abdomen is opened by a midline incision which is made between the ensiform process and the um bilicus The peritoneum and the transversalis fascia, situated behind the right rectus muscle, are cut transversely, and the lower lip is mobilized by separating it from the superimposed muscle so as to form a pocket The liver is replaced *in its normal position*, and *its* lower edge is placed *in* this pocket The peritoneal edge of the lower lip is sutured to the posterior surface of the liver, thus preventing the edge of the liver from slipping out of the pocket The abdomen is closed in layers

This method is a further improvement of a similar method which was described by Foderl, in 1908 However, the method, in reality is not new

at all. As early as 1895, Rydygier employed a similar procedure for fixation of a movable spleen, a description of which is given in the Chapter on "Surgery of the Spleen."

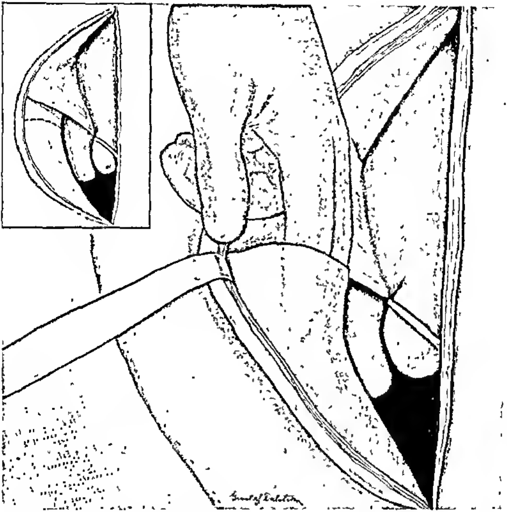

FIG 293. Hepatopexy (Föderl-Kaiser method). *Insert*—A transverse incision is made in the posterior sheath of the rectus muscle *Main picture*—A pocket is made between the rectus muscle and its posterior sheath.

4. Ellsworth Eliot Method.

The abdomen is opened by a midline incision between the ensiform process and the umbilicus. The hepatopexy operation, as described by the originator, is as follows:

"The obliterated umbilical vein, forming a thick cord in the free edge of the falciform ligament, is then identified and drawn forward until it comes in contact with the parietal peritoneum. The hepatic extremity of

the ligament then rests against the under surface of the right lobe of the liver in front of the transverse fissure The lower or umbilical extremity is in close contact with the anterior parietal peritoneum, the two portions of the ligament now forming a right angle In this position the round ligament is sutured to the anterior parietal peritoneum with chromic gut and the redundant falciform peritoneal reflection is spread out laterally and sutured to the contiguous portion of the parietal peritoneum with the same material *In this manner a shelf is formed for the under surface of the liver* The abdominal wound is then closed in layers"

E Excision of a portion of the anterior abdominal wall (laparectomy)—Depage method

This method was used for those cases in which hepatoptosis was only one feature of general splanchnoptosis For this condition Depage considered hepatopexy only as a palliative procedure He believed that general splanchnoptosis is largely due to a general weakening of the abdominal wall, and he remedied it by the excision of a part of this wall, diminishing the wall in two dimensions

In several cases operated upon by this method the results were satisfactory There was a relief of the symptoms of splanchnoptosis and no hernia formation followed However, with the development of other methods of surgical treatment of splanchnoptosis, the Depage method will hardly appeal to a modern surgeon

F A combination of the above mentioned methods

Some surgeons are using not only one or another type of operation but a combination of some features from the different types It seems to us that the best results are obtained by immobilizing the liver by forming adhesions between its upper surface and the diaphragm, reinforcing this by a suspension operation with the aid of the round ligament which is attached either to the abdominal wall or still better to the chest wall, and finally, immobilizing the liver by forming a peritoneal partition below it This operation is as follows

Step 1 The abdomen is opened by a transverse incision running from the tenth right costal cartilage to the midline

Step 2 The patient is placed in the Trendelenburg position The upper surface of the liver and the diaphragm are vigorously rubbed with gauze The liver is placed in its normal position The round ligament is brought outside the abdominal cavity through a small incision made above the cartilage of the ninth rib, and then returned into the abdominal cavity through a small incision made below the cartilage of the same rib, so that the round ligament forms a loop around the cartilage of this rib The two

limbs of the round ligament are sutured to each other (Fig. 292).

Step 3. The peritoneum and the transversalis fascia of the upper lip are separated from the superimposed structures and sutured to the inferior *surface of the liver, thus forming a pocket.*

The operation thus performed produces fixation and suspension of the liver, and reinforcing this from below makes it analogous to fixation or suspension of the uterus with reinforcement of the pelvic floor by perineorrhaphy.

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CHAPTER XXII

SURGERY OF THE SPLEEN

I DIFFERENT ROUTES FOR EXPOSURE OF THE SPLEEN

The routes for exposure of the spleen are the same as for the liver, with this difference only that in the latter they are made on the right side, whereas for the spleen they are made on the left side

II SPLENOTOMY

Definition

This term consists of two Greek words σπλήν, spleen, and τέμνειν, to cut It signifies an incision of the spleen

Indications

a Abscess

b Large single cyst In the case of numerous cysts splenectomy is indicated

Technic

This operation can be done either as a one or a two stage operation

One-stage Operation

Step 1 The abdomen is opened by one of the incisions already described

Step 2 The spleen is isolated from the rest of the peritoneal cavity by tampons the ends of which are brought outside the abdominal cavity Exploratory puncture by a needle is made to ascertain the location of the abscess If pus is found, an incision through the capsule is made and the pus is evacuated A roll of gauze with a rubber drain is introduced into the cavity in the spleen and the ends are brought outside the abdominal cavity The abdomen is closed in layers, leaving openings at the upper and lower angles of the wound for the ends of the gauze rolls A few days later, the tampons which "walled off" the spleen and lie in the abdominal cavity are removed By this time, adhesions have been formed which prevent contamination of the general peritoneal cavity A few days later, the tampon and rubber drain are removed from the cavity in the spleen The majority of surgeons prefer the one stage method

III SUTURE OF THE SPLEEN (SPLENORRHAPHY)

Indications

Wound of the spleen This method is suitable only for small wounds

In the case of a large wound, it is difficult to stop the bleeding by the suture method, and for this reason splenectomy should be given preference. The first successful splenorrhaphy for a wounded spleen was performed by Parlavecchio, in 1893.

Step 1. The abdomen is opened.

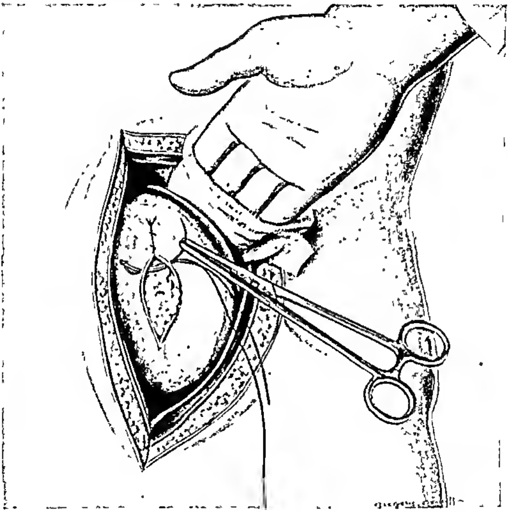

FIG 294. Splenorrhaphy.

Step 2. A large piece of omentum is excised and tucked into the open wound in the spleen. This will act not only as a tampon but as an active coagulant. The edges of the capsule of the spleen are sutured to each other with heavy catgut over the piece of omentum (Fig. 294).

IV. SPLENOPEXY

Definition.

The term consists of two Greek words: σπλήν, spleen and πῆξις, to

fasten It signifies "fixation of the spleen" The fixation may be either intraperitoneal or extraperitoneal, or combined intra- and extraperitoneal

Indications

a Movable spleen, when this condition is the cause of symptoms, mostly pressure on the adjacent structures and particularly on the colon

Fig 295 Splenopexy (Rydygier method) *Insert*—Incision of the parietal peritoneum on the posterior abdominal wall *Main picture*—Formation of a pocket

b As one of the methods of treatment of ascites due to cirrhosis of the liver Tuffier was the first who performed a splenopexy, in 1882 The next who performed it was Kouwer, of Haarlem, Netherland, in 1891 However, interest in this operation was revived by Rydygier, who performed his first case in 1895 Since that time this operation has been used by many surgeons

1. KOUWER METHOD

Step 1. The abdomen is opened.

Step 2. Between the upper and lower surfaces of the spleen and the corresponding surfaces of the diaphragm are placed gauze tampons which are brought outside the abdominal cavity. The spleen is placed back in

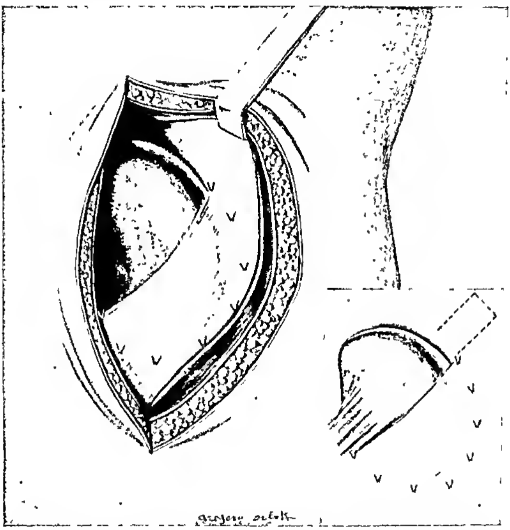

FIG. 296. Splenopexy (Rydygier method). *Insert*—Formation of a peritoneal flap to cover a portion of the spleen. *Main picture*—The lower pole of the spleen is placed in the pocket.

its normal position. A few days later, the tampons are removed. By this time adhesions will be formed between the spleen and the diaphragm.

Some surgeons are even yet using this method. They only supplement this technic by vigorously rubbing the diaphragmatic surface of the spleen and the diaphragm with gauze in order to facilitate the formation of adhesions before they place the gauze-tampons.

2 RYDYGIER METHOD

This method was reported to the XXIV Congress of the Deutsche Gesellschaft fur Chirurgie, in April, 1895.

Step 1. The abdomen is opened in the left hypochondrium.

Step 2. A slightly convex incision running somewhat upward (Fig 295,

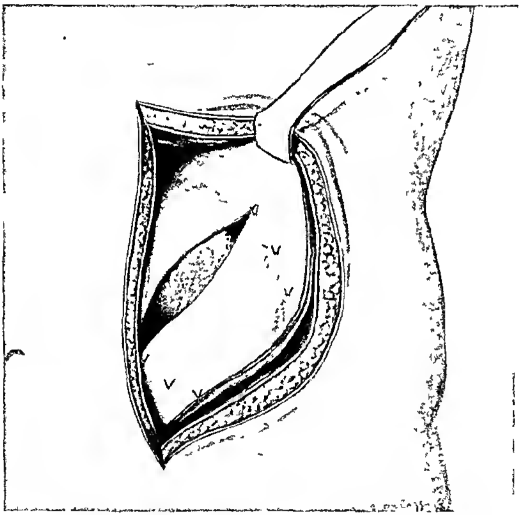

FIG 297 Splenopexy (Rydygier method) Placing the upper pole of the spleen in the upper pocket

insert), the length of which should be equal to the width of the spleen, is made on the inner surface of the thoraco-abdominal wall from below upward extending from the eleventh to the ninth ribs The peritoneum of the lower lip which is thus formed is separated bluntly from the superimposed soft tissues, so that a pocket is formed with its bottom directed downward (Fig. 295). The lower pole of the spleen is placed in this pocket

(Fig. 296). In order to prevent further separation of the peritoneum from the superimposed structures of the pocket by the lower pole of the spleen, the peritoneum is sutured to the superficially lying structures by a series of interrupted sutures approximately half an inch away from the distal end of the bottom of the pocket (Fig. 296).

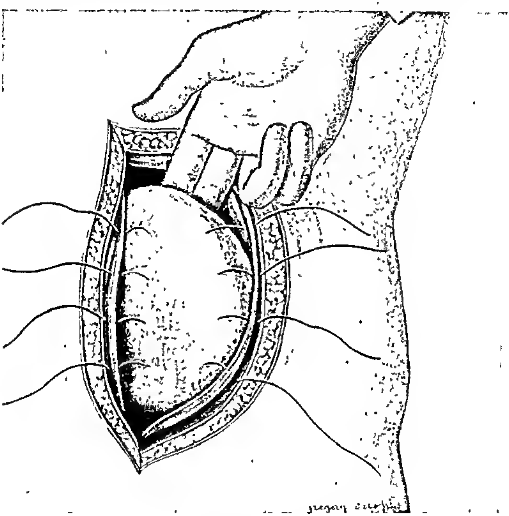

FIG. 298. Splenopexy (Tuffier method).

Step 3. The upper lip of the peritoneum is separated from the muscle of the diaphragm so as to form an upper pocket into which the upper pole of the spleen is placed (Fig. 297).

[Whereas Step 2 is an essential part of the Rydygier method, Step 3 is done only in case it is possible to form an upper pocket, since in many cases it is difficult to separate the peritoneum from the muscle of the diaphragm.]

In order to reinforce the new position of the spleen in those cases in which only the lower pocket was made, Rydygier made a ᔭ-shaped peritoneal flap laterally to the spleen and reflected this medially, so that it covered the anterior surface of the spleen, and then sutured the free border of the flap to the gastro-splenic ligament (Fig. 296, insert). How-

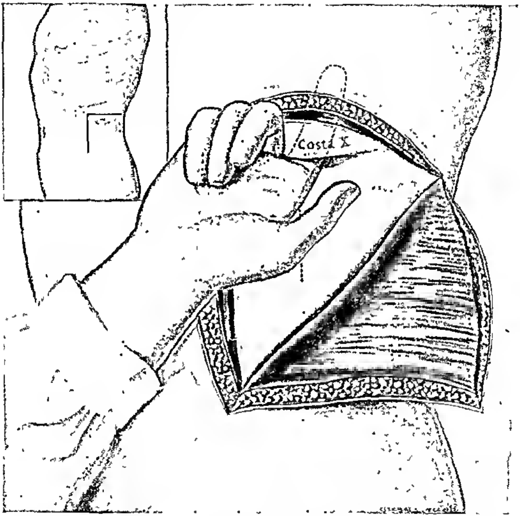

FIG. 299. Splenopexy (Bardenheuer method). Separation of the peritoneum from the superimposed structures.

ever, this step is not essential. The true characteristic feature of the Rydygier method is the formation of a lower pocket into which is placed the lower pole of the spleen.

3. TUFFIER METHOD. (FIG. 298)

This method consists in suturing the spleen to the abdominal parieties. A bite is taken through the entire thickness of the abdominal wall, except

the skin, of one lip. Then one is taken through the spleen, penetrating not only the capsule but also a thick layer of the parenchyma of the spleen, then again through the entire thickness of the abdominal wall, except the skin, of the other lip. The number of sutures depends upon the size of the spleen. These sutures are not tied at this time. This is postponed until all the layers of the abdomen (except the skin) have been sutured. Then the splenopexy sutures are tied. After this the skin is closed.

Although the name of Greifenhagen has been attached to this method, it is, however, the method which was used first by Tuffier and later by Kouwer in his very first case of splenopexy, but which he (Kouwer) did not subsequently use on account of the danger of hemorrhage.

4. BARDENHEUER METHOD

This method was described by Plücker, one of Bardenheuer's associates, in October, 1895.

Step 1. The abdominal cavity is opened by an incision running along the left midaxillary line, starting immediately above the crest of the ilium and extending for four inches upward until the tenth left rib is almost reached (Fig. 299, insert). Then it turns laterally nearly perpendicularly to the vertical incision and runs for another four inches. The entire thickness of the flap thus formed is cut down to the peritoneum, which is not yet opened. This musculo-cutaneous flap is reflected (Fig. 299).

Step 2. The exposed peritoneum is separated from the superimposed soft tissues as far as possible upward and downward (Fig. 299). A small incision is made through the peritoneum, just large enough to draw the spleen outside of the abdominal cavity (Fig. 300). The spleen is placed extraperitoneally in the sac thus formed, precisely in the same position as it lies normally intraperitoneally (Fig. 300). The slit in the peritoneum is sutured to the gastro-splenic ligament.

Step 3. A thread of silkworm-gut is passed around the tenth rib (which is freely exposed for this purpose), and then through the lower pole of the spleen (Fig. 300). The ends of this thread are not tied at this time. A series of interrupted sutures are inserted between the lowermost part of the separated peritoneum and the superimposed structures, so as to prevent separation of the peritoneum from these structures in a downward direction, thereby preventing a downward slipping of the lower pole of the spleen. Then the long ends of the silkworm-gut thread which fixed the lower pole of the spleen to the tenth rib are tied and the ends are cut short. The wound is closed in layers.

Thus, this method is characterized by placing the spleen extraperitoneally, attaching the hilum to the peritoneum, and fixing the lower pole to the tenth rib.

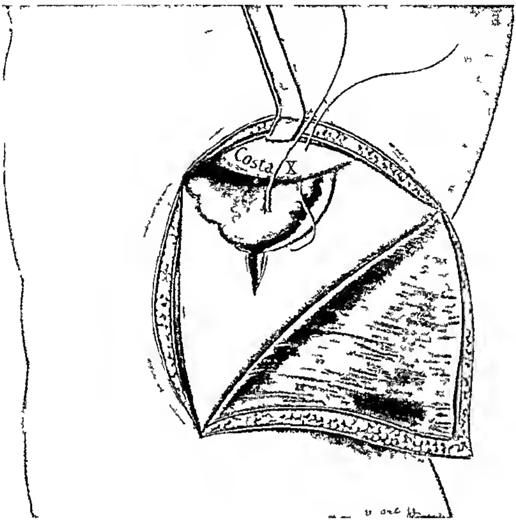

FIG 300 Splenopexy (Bardenheuer method) Fixing the lower pole of the spleen to the tenth rib

5 SCHIASSI METHOD (SPLENOCLEISIS)

The term splenocleisis consists of two Greek words σπλην spleen and κλεισις, closure It signifies ' closure of the spleen "

This method consists in producing extensive adhesions between the spleen and all the surrounding tissues, including the anterior abdominal wall A thick capsule is formed around the spleen which compresses that organ thus diminishing the amount of blood passing through the spleen and increasing the degree of anastomosis of the veins between the portal and systemic venous systems This method was published in 1906 and again suggested in 1934

Indications.

The method is used as a substitute for splenectomy in cases of blood-diseases in which splenectomy, for some reason, is hazardous. It is practically the substitution of a physiological for a mechanical splenectomy.

Technic.

Step 1. The abdomen is opened by an incision starting at the middle line and running parallel to and two fingers below the left costal arch until the left midaxillary line is reached.

Step 2. A roll of gauze is placed behind and below the lower pole of the spleen, another medially to the hilum, a third laterally to the lateral border, a fourth above and behind the upper pole, and a fifth and a sixth between the antero-lateral and antero-medial surfaces of the spleen and the anterior abdominal wall. The ends of all these rolls are brought outside the abdominal wound through its upper and lower angles. The anterior surface of the spleen is scarified.

Step 3. The abdominal wall is sutured in layers.

On the fifth day the roll is removed from the upper pole, and each following day another roll of gauze is removed. The last roll is removed from the lower pole.

As already mentioned, this operation produces a large amount of connective tissue around the spleen, which compresses the organ.

V. LIGATION OF THE ENTIRE SPLENIC PEDICLE OR OF THE SPLENIC ARTERY ALONE

a. The ligation of the entire pedicle has been performed as a substitute for splenectomy. It may be advisable to do this in cases in which extensive adhesions between the spleen and the diaphragm make splenectomy a very difficult procedure. However, in some cases gangrene of the spleen may follow this procedure. For this reason it is very seldom used now.

b. Ligation of the artery only was done first by Clément Lucas, in 1882, as a substitute for splenectomy. It was performed also by Stubenrauch for thrombopenia, as a substitute for splenectomy, since, if the vein is not injured, ligation of the artery may produce the desired atrophy of the spleen.

Ligation of the artery, as a therapeutic measure for the treatment of ascites due to cirrhosis of the liver, was advocated by E. Holman, in 1933. However, further observations are necessary to show whether or not this procedure should be recommended.

VI. SPLENECTOMY

Historical

Splenectomy was first performed by Zacarelli, of Palermo, in 1549, for an enlarged spleen. The patient recovered. To Viard is given the credit of being the first, in 1581, to remove the spleen, which prolapsed through the wounded anterior abdominal wall. This patient also recovered. Since that time, due to technical difficulties, this operation has been used very infrequently. The first deliberately planned splenectomy on a human, *with preliminary practice on animals for this purpose*, was made by Quittenbaum, in 1826. The patient died after the operation. In the middle of the Nineteenth Century interest in this operation was again revived. Kuchler, of Darmstadt, performed it in 1855 for the removal of an enlarged malarial spleen (the patient died from hemorrhage a few hours after the operation), and G. Volney Dorsey, of Piqua, Ohio, performed it in the same year for the same condition. His patient recovered. This case may be *considered as the first successfully performed splenectomy for malaria* in modern times. Péan, in 1864, was the first to perform a splenectomy for unilocular cyst of the spleen (the patient recovered). Koeberlé was the first who performed splenectomy for echinococcus, in 1873. For Banti's disease the first splenectomy was performed in 1881. Picou and Ramond were the first to perform splenectomy for Gaucher disease, in 1896. Micheli was the first to perform splenectomy for hemolytic icterus, in 1906, and Schloffer was the first to perform it for thrombopenia, in 1917.

Definition

The term splenectomy consists of two Greek words *σπλην*, spleen and *ἐκτομη*, excision. It means "excision of the spleen."

Indications

There are many indications for the performance of this operation.

1. **Rupture of the Spleen.**

In some cases it may be advisable to suture the torn edges, but usually splenectomy is indicated for this condition.

2. **Wandering Spleen.**

The majority of surgeons prefer to perform splenopexy for this condition. However, if torsion of the pedicle occurs, splenectomy is the only remedy.

3. **Abscess of the Spleen.**

Splenectomy is advisable only in cases in which there is no thrombophlebitis, the presence of which strongly suggests the existence of abscesses in the liver, which makes the operation useless.

4. **Non-parasitic Cysts.**

5. **Parasitic Cysts (Echinococcus).**

6. **Isolated Primary Tuberculosis of the Spleen.**

In case this is of the secondary form, splenectomy is contraindicated.

7. Greatly enlarged **malarial spleens,** if their size produces distressing symptoms. Splenectomy will not alleviate the disease itself.

8. **Leukemia.**

Splenectomy does not alleviate this disease. It is indicated only when the greatly enlarged spleen produces mechanical difficulties, or threatens to rupture. Lately, many give preference to X-ray therapy.

9. **Malignant Tumors.**

Splenectomy is indicated only in those cases which are primary, and when no metastases are present.

10. **Hemolytic Jaundice.**

Splenectomy gives a symptomatic cure in the majority of the cases.

11. **Anemia Splenica Infantum (Jaksch-Hayem Anemia).**

Splenectomy should be preceded by medical treatment, which frequently gives good results. In obstinate cases which do not yield to medical treatment, splenectomy combined with a few repeated blood-transfusions gives excellent results.

12. **Gaucher Disease (Large-cell Splenomegaly).**

Splenectomy does not cure this condition. It gives only mechanical relief. However, cases have been observed in which a long continued remission has followed the operation.

13. **Splenic Anemia (including Banti Disease).**

Splenectomy gives excellent results in the first stage of this disease. In the second stage (which is characterized by anemia, leukopenia and gastro-intestinal manifestations), the results are not so good. In the third stage (Banti disease proper), the results are unsatisfactory. Many believe that at this stage splenectomy should not be performed at all. Even the followers of splenectomy believe that it should be supplemented by some type of the Talma operation.

14. **Essential Thrombopenia.**

Splenectomy gives good results in early cases. Some (Stubenrauch) had good results following ligation of the splenic artery only.

15. **Splenomegaly of Unknown Origin.**

Splenectomy is done only when mechanical difficulties arise, due to the size of the spleen.

16. **Thrombosis of the Splenic Vein.**

Splenectomy should be done, since gangrene of the spleen may occur.

17. **Infarct of the Spleen.**

This condition arises occasionally as a complication of typhus fever.

18. **Kala-Azar (Leishman Disease).**

Splenectomy should be done only in those cases which have responded to a previous treatment with antimony (tartar emetic) and in which the spleen is not enlarged. Otherwise, splenectomy is of no avail.

19. **Cirrhosis of the Liver with Ascites.**

Splenectomy is used by some surgeons with the object of removing a

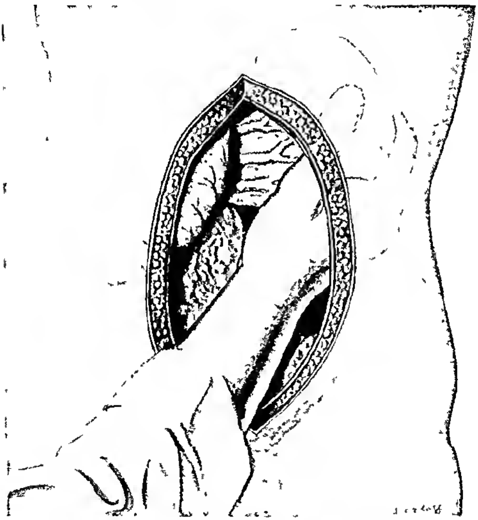

FIG 301 Splenectomy Manual separation of the spleen from its bed

very important tributary of the portal vein. However, the majority of surgeons give preference to splenopexy, and we are in complete accord with them.

Technic.

The operation may be very simple, when the pedicle is long, the spleen movable, and no adhesions are present. In cases in which the spleen is very

much enlarged, the pedicle short, and many adhesions are present, the operation may offer insurmountable difficulties, so that many experienced surgeons under circumstances prefer not to perform the splenectomy.

There are two methods used in removing the spleen, namely, either to start with separation of the spleen from the diaphragm, with ligation

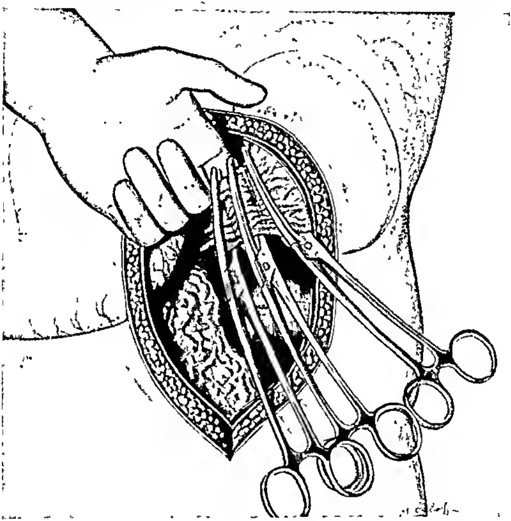

FIG. 302. Splenectomy. Cutting of the splenic pedicle between clamps.

of the pedicle as the last step of the operation, or to start the operation with ligation of the pedicle, and separation of the spleen from the diaphragm as the last step. Both operative types have many followers.

Step 1. The abdomen is opened.

Step 2. The spleen is separated from the diaphragm by the hand (Fig. 301). If strong adhesions are present, they are cut by scissors between clamps. As soon as the spleen is lifted from the diaphragm, large packs,

moistened in hot normal salt solution, are introduced and placed upon the exposed bed of the spleen Two things are thus accomplished

a Checking of the venous oozing from the diaphragm

b The facilitation of further manipulation of the spleen, such as clamping of the pedicle, etc

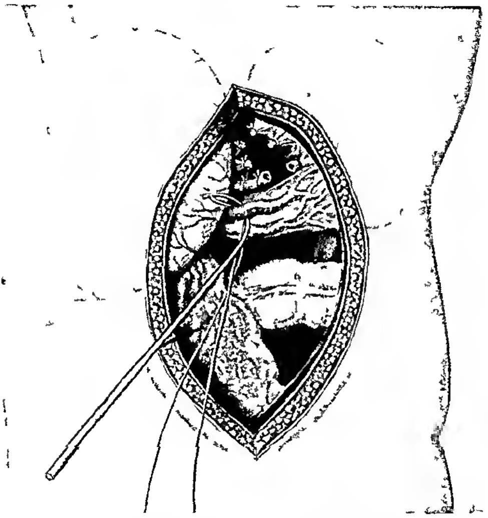

Fig 303 Splenectomy Ligation of the blood vessels of the splenic pedicle

Step 3 The gastro splenic ligament above the pedicle is divided between clamps, care being taken not to injure the fundus of the stomach which lies very close to the spleen (Fig 302)

Step 4 Ligation of the Splenic Pedicle

This can be done either "en masse" or in sections The latter should be given preference

If the ligation is done in sections, the artery should be ligated first

so as to give the vein a short time to carry away the blood from the spleen. [We should remember that the splenic artery runs either as a single trunk or is already divided into two branches. The vein is still composed of two or three branches and runs below the artery.] If the stump is ligated "en masse," three large curved arterial forceps clamp the pedicle, which is cut between the clamp closest to the spleen and the middle one. In this manner, two clamps will safeguard against hemorrhage from the splenic artery and one from the splenic vein. The stump is ligated twice with a double strand of No. 2 plain catgut.

Before clamping the splenic pedicle the surgeon should obtain a clear view of it posteriorly, since not infrequently the tail of the pancreas reaches nearly to the hilum of the spleen, and in such cases may actually be adherent to the splenic pedicle posteriorly. By clamping the pedicle without a previous separation of the tail, part of the pancreas may be caught in the clamp.

Step 5. All additional ligaments connecting the spleen with surrounding structures should be cut between two clamps and carefully ligated.

Step 6. The moist pack is removed from the bed of the spleen.

Step 7. The abdomen is closed in layers.

Alternate Method in which the Pedicle is Ligated first (Fig. 303).

Step 1. The abdomen is opened.

Step 2. The spleen is pushed laterally, so as to expose clearly the gastro-splenic omentum above the pedicle, which is then divided between the clamps. The finger is introduced through the opening thus formed and slipped behind the pedicle. The tail of the pancreas lies behind and the pedicle in front of the finger. The pedicle is ligated either sectionally or "en masse."

Step 3. The spleen is separated from the diaphragm and removed.

Step 4. The abdomen is closed in layers.

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CHAPTER XXIII

SURGERY OF THE PANCREAS

I SURGICAL ANATOMY OF THE PANCREAS

The pancreas is an elongated, narrow viscus, the length of which is from 15 to 26 cm , the width from 4 to 9 cm , and the thickness from 2 to 3 cm It extends from the second portion of the duodenum nearly to the hilum of the spleen It is subdivided into four parts head, neck, body, and tail

a Holotopic Relations

The pancreas starts in the right hypochondrium, traverses the epigastric region and ends in the left hypochondrium

b Skeletotopic Relations

The head of the pancreas is situated to the right of the first, second and, occasionally, the third lumbar vertebra The body runs in a slightly upward direction across the body of the first lumbar vertebra, and the tail ends in the left hypochondrium at the level of the eleventh or twelfth thoracic vertebra

c Syntopic Relations

The pancreas lies between the posterior wall of the stomach in front and the posterior abdominal wall, including the great blood-vessels, behind It is covered in front by the parietal peritoneum of the posterior abdominal wall It is separated from the posterior wall of the stomach by the bursa omentalis

Behind the body of the pancreas lies the solar plexus This is the reason why the pain in tumor or swelling of the pancreas is almost unbearable

The blood supply of the pancreas is derived from one of the terminal branches of the gastro-duodenal branch of the hepatic artery (arteria pancreatico-duodenalis superioris), from the inferior pancreatico-duodenal artery, which is a branch of the superior mesenteric artery, and from small branches of the splenic artery The veins are tributaries either of the superior mesenteric or of the splenic vein

The Wirsung's duct was described by the German anatomist Wirsung, in 1642, although he did not know its exact purpose The accessory pancreatic duct, although known as the duct of Santorini, was described before him by Graaf and by Haller The further syntopic relations of the different portions of the pancreas are as follows

1 The Head

Behind the head are the right renal artery and vein, the common bile-duct, which quite frequently is incorporated into its substance, the pan

creatic duct, the vena cava inferior, the superior mesenteric vein and the abdominal aorta. Some believe that most frequently the portion of the pancreas lying in front of the superior mesenteric vein and artery is the neck of the pancreas.

In front of the head are the anastomosis between the superior and inferior pancreatico-duodenal arteries (which runs in the groove between the head and the concavity of the duodenum), and the parietal peritoneum of the posterior abdominal wall. At the upper border of the head, the portal vein, formed by the merging of the splenic and superior mesenteric veins appears. [However, quite often the splenic and the superior mesenteric veins unite below the upper border of the pancreas. In such cases a portion of the portal vein lies behind the pancreas.]

2. The Body.

The structures lying behind the body are the superior mesenteric artery, the splenic vein, the inferior mesenteric vein, and, occasionally, the splenic artery [which in most cases runs in front of the pancreas]. In front are the parietal peritoneum of the posterior abdominal wall (which separates it from the anteriorly situated stomach) and, usually, also the splenic artery. At the lower border are the superior mesenteric artery and vein and the duodeno-jejunal junction of the bowel.

3. Tail.

Behind this portion of the pancreas are the splenic vein and occasionally the splenic artery, the upper pole of the left kidney and, occasionally, the left renal artery and vein. In front, are the parietal peritoneum of the posterior abdominal wall (which separates it from the stomach) and the splenic artery. The tail reaches occasionally as far as the hilum of the spleen.

DIFFERENT ROUTES FOR EXPOSURE OF THE PANCREAS

The pancreas may be reached either through the anterior or posterior abdominal wall.

A. Anterior Route.

This can be accomplished in six different ways:

a. Through the gastro-hepatic ligament.

b. Through the anterior and posterior walls of the stomach.

c. Through the gastro-colic ligament.

d. Through the transverse mesocolon.

e. Through the mobilization of the duodenum in order to reach the posterior surface of the head of the pancreas.

f. Retro-omental.

a. Approach through the gastro-hepatic ligament (Fig. 230).

This route is advisable only in cases in which either there is a marked

gastroptosis, or if the pancreas is situated higher than normally The latter is a rare condition

b Through the anterior and posterior gastric walls

This approach is unusual and not advisable However a case is recorded (Hagen) in which this approach was the only one possible

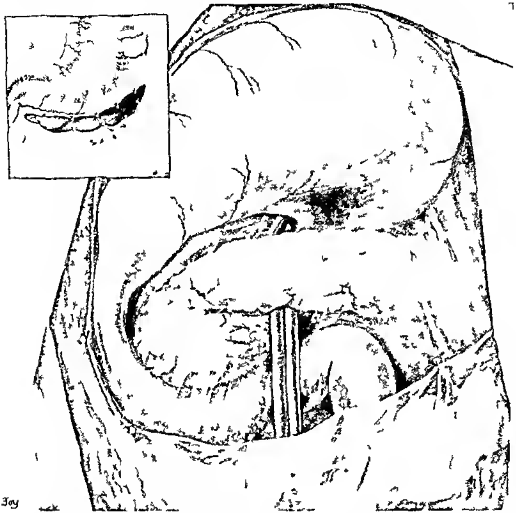

FIG 304 Exposure of the pancreas The gastrocolic ligament is cut and the stomach is reflected upward

c Through the gastro-colic ligament (Figs 232 and 304)

This is the best approach and it is employed more frequently than any other

d Through the transverse mesocolon (Fig 201)

This approach is not advisable, particularly if drainage through the anterior abdominal wall is contemplated

e. Approach through the mobilization of the second portion of the duodenum.

This is an excellent approach to the posterior surface of the head of the pancreas (Fig. 221).

f. Retro-omental route of approach.

The omentum is lifted and put on the stretch. The serosa of the transverse colon is incised along the line of junction with the omentum. A finger is introduced into the opening thus formed, ond the bowel is separated bluntly from the omentum. Thus, a large opening is made which exposes the posterior wall of the stomach, the pancreas, and also the third portion of the duodenum.

B. Posterior Route.

This is possibly only when surgery of the tail is contemplated. The body of the pancreas is not accessible by this route, since the spinal column lies behind it. This route is not advisable for the head, on account of the important structures lying behind the head, and the poor accessibility of this region.

II. OPERATIONS FOR ACUTE PANCREATITIS

If the patient is in a state of profound shock, operation is hardly advisoble. However, if there is no shock, then the patient should alwoys be operated upon, and the sooner the better. The oim of the operotion is to incise the capsule (so as to relieve the intracapsular pressure ond to prevent ony further compression of the blood-vessels, and thus increase the resistance of the gland), and to prevent the escape of exudate into the free peritoneal cavity hy "walling off" the gland from the rest of this cavity. The operation then is os follows:

Step 1. The abdomen is opened by a midline incision extending from the ensiform process down to the umbilicus.

Step 2. The gastrocolic ligament is cut (as described in Chapter VIII), and the stomach is turned upward, thereby exposing the pancreas.

Step 3. The lesser peritoneal cavity is packed with rolls of gauze, which surround the pancreas, and the ends of which are brought outside the abdominal cavity.

Step 4. The capsule of the pancreas is incised in several places in a direction parallel to the pancreatic ducts, and a gauze-drain is placed over the incised capsule.

Step 5. Cholecystostomy is done (or choledochostomy, if the cystic duct is blocked hy a stone).

Cholecystostomy is just as an important step of the operation as the others, since the external drainage of bile will prevent it from running into Wirsung's duct and reinfecting the pancreas, which is the most impor-

tant etiological factor in producing pancreatitis No attempt should be made at this stage to do any radical biliary surgery This should be deferred to some future time when the condition of the patient is improved

III OPERATIONS FOR CHRONIC PANCREATITIS

The most commonly used procedure consists of cholecystectomy, after which the sphincter of Oddi becomes paralyzed and does not offer any resistance to the passage of bile into the duodenum [Of course, it is understood that before closing the abdomen the surgeon should be certain that no stones are left in the common bile duct] The next most common method employed consists in making numerous incisions in the pancreatic capsule alone, or even of cutting into the parenchyma of the pancreas in order to diminish the intracapsular pressure However, many surgeons, quite justly, are opposed to cutting the pancreatic substance for fear of a possible hemorrhage, and are content with cutting the capsule alone Next in frequency is drainage of the bile, externally by a cholecystostomy, or internally by cholecysto-gastrostomy or cholecysto enterostomy We believe that the safest of all procedures is to produce internal drainage of bile by means of a cholecysto-gastrostomy

IV OPERATIONS FOR STONES IN THE PANCREATIC DUCT (FIG 305)

The occurrence of stones in the pancreatic duct was recorded by Graaf, in 1667, when he mentioned the observations of Panarol and Gæia Bonetus, in 1700, Galeati, in 1757, Morgagni, in 1765, Greding in 1769, and Cowley, in 1788 reported cases in which pancreatic stones were found Cowley's case is the first of pancreatic stones published in England However, these cases are very infrequent Johnston, in 1883, was able to collect from the literature only 35 cases of pancreatic stones, and Giudiceandrea, in 1896 only 48 cases However, Opitz, in 1901, was able to collect 97 cases of pancreatic stones This number includes all the cases found in operation and on the dissecting-table Guleke, in 1924, was able to collect 25 cases in which operation had been performed and Schmieden, in 1927, twenty cases more, thus making a total of 45 cases up to the year 1927

The stones, which were found, were most frequently single However, two, three or more stones have been found, and a case is reported in which 54 stones were found The size of the stone varies from a grain of sand to 2½ inches by half an inch (case of Schupman) In Matani's case, the weight of the stone was two ounces Most frequently the stones are met with in the head, then in the body, and finally in the tail

The presence of pancreatic stones is associated with changes in the pancreatic tissue, such as cystic degeneration and acute and chronic pancreatitis Whether the stones are the cause or sequela of these changes or just a concomitant manifestation is unsettled

Treatment.

This is surgical only. The prognosis of cases of untreated stones is bad, whereas, if they are removed it is excellent. The approach depends on whether the stones are in the head, body or tail of the pancreas. If the stone is located in the head (and this is true in the majority of cases)

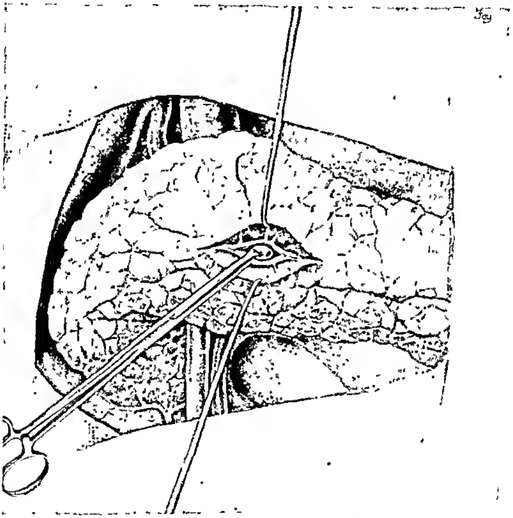

FIG. 305. Removal of a pancreatic stone.

then the approach is either transduodenal or retroduodenal. If, however, the stone is located in the body or in the tail, the approach is made either by cutting the gastrocolic ligament, or, less frequently, by cutting the gastro-hepatic ligament, thus exposing the pancreas, and then cutting through the pancreatic tissue and the duct. One should never fail after opening the duct to probe it in order to ascertain whether all the stones have been removed.

Before the pancreatic tissue is cut, the line of intended incision is surrounded by gauze the ends of which are brought outside the abdominal cavity. The gland and the duct are opened, the stone removed, the gland with the duct resutured, and the gauze-drain left for several days. Moynihan was the first who made a transduodenal extraction of a stone after a preliminary correct diagnosis.

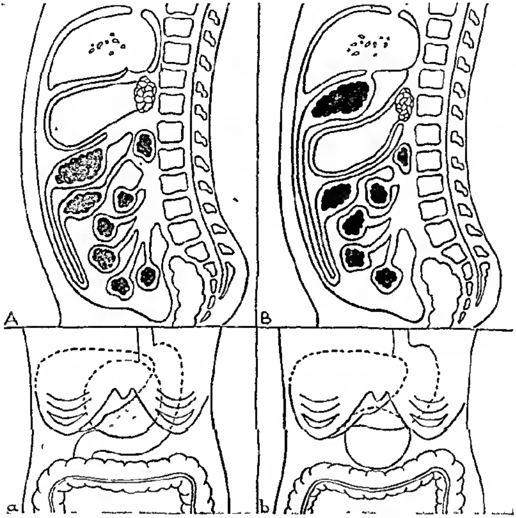

Fig 306 Front and lateral views of pancreatic cysts (after Körte)

V. OPERATIONS FOR PANCREATIC CYSTS

Körte divides all varieties of cysts into the following sub-groups:

1. Retention cysts;
2. Proliferation cysts;
3. Degeneration cysts;
4. Pseudo-cysts;

5. *Echinococcus cysts.*

The common site of pancreatic cysts is shown in Figs. 306 and 307.

Three methods of treatment are used:

a. Incision and drainage of the cyst-cavity.

b. Extirpation of the cyst.

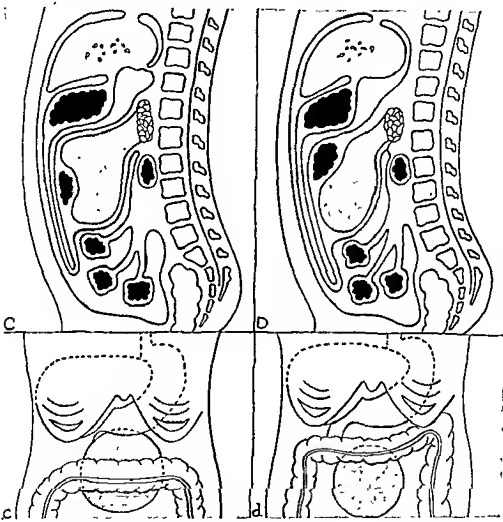

FIG 307. Front and lateral views of pancreatic cysts (after Körte).

c. Partial removal of the cyst and implantation of its remnants into the stomach, duodenum, or gall-bladder.

a. INCISION AND DRAINAGE OF THE CYST-CAVITY

This is done by the majority of surgeons as a one-stage operation, although some surgeons perform it by the two-stage technic.

Technic.

Step 1. The abdomen is opened by a midline incision extending from the ensiform process to the umbilicus

Step 2. The gastrocolic ligament is cut, the stomach is turned upward so that the pancreas is well exposed (Fig 304), and the cyst is "walled off" from the rest of the peritoneal cavity by gauze rolls

Step 3. A needle is thrust into the cystic cavity and the fluid is aspirated Then the opening is enlarged and the cavity is immediately packed with gauze the ends of which are brought outside the abdominal cavity

Step 4 The gauze surrounding the pancreas is removed The wall of the pancreatic cyst is sutured to the parietal peritoneum of the anterior abdominal wall (Marsupialization of the cyst)

This is a good method for all types of cysts except the malignant variety of adenocystoma, which should be treated by extirpation only.

b EXTIRPATION OF THE CYST

This method is technically difficult, since the wall of the cyst is usually strongly adherent to the pancreatic tissue and is surrounded by numerous blood-vessels For this reason, this method should be employed only for the malignant type of cysts

In the early days of surgery of the pancreas some treated the cysts by aspirating its contents by a trocar passed through the cyst This should never be employed, since it is dangerous and the results are very unsatisfactory.

The results of treatment of cysts by excision and drainage or by extirpation are good A cure follows in more than ninety per cent

c IMPLANTATION OF THE REMNANT OF THE CYST INTO THE DUODENUM STOMACH OR GALL-BLADDER (PANCREATO DUODENOSTOMY PANCREATO GASTROSTOMY PANCREATO CHOLECYSTOSTOMY)

In order to prevent the occurrence of a pancreatic fistula in cases in which the cyst cannot be entirely removed, R Jedlicka, in 1921, advised implanting the remnant of the cyst connected with the pancreas into the posterior wall of the stomach He suggested doing this not as a secondary operation, when a fistula is already formed, but as one of the steps of the primary operation. As a secondary operation it was used many years previously by Kehr and Michon Moreover, the implantation of the remnant of the cyst into the duodenum as a primary operation was performed much earlier than was done by Jedlicka, namely by Ombrédanne, in 1911 Hammesfahr, in 1923, implanted the remnants of the pancreatic cyst into the gall-bladder

VI. OPERATIONS FOR INJURY OF THE PANCREAS (FIG. 308)

An exploratory abdominal section for injuries of the upper abdomen is not complete unless the pancreas is examined. Time and again cases have been reported in which injury to other organs have been repaired, in which the patient died soon afterward, and autopsy showed a torn or

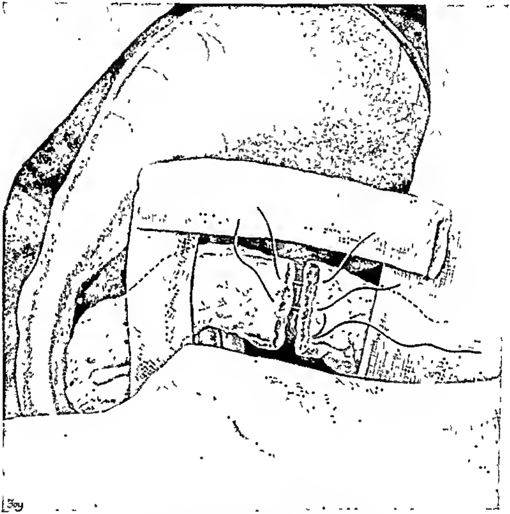

FIG. 308. Suture of a ruptured pancreas.

badly damaged pancreas. The danger in pancreatic injuries lies in hemorrhage and in the escape of pancreatic juice.

Technic.

Step 1. The abdomen is opened by a midline incision extending from the ensiform process down to the umbilicus.

Step 2. The gastro-hepatic ligament is opened for inspection of the pancreas. If it is found to be injured it should immediately be packed

around with gauze, the ends of which are brought outside [If there is not a good exposure through this ligament, then the gastrocolic ligament should be cut and the stomach reflected upward This will insure an excellent exposure]

Step 3 A heavy catgut suture penetrates the thickness of the pancreatic tissue and the capsule on each side of the pancreatic wound The ends are tied and cut short This will arrest profuse hemorrhage If the length of the torn portion is considerable, two or three such deep sutures are inserted If necessary, a few superficial sutures of fine catgut may be inserted between the deeper sutures This will stop the superficial hemorrhage

In placing the deep sutures care should be taken not to injure or to occlude Wirsung's or the Santorini's pancreatic duct

Step 4 A rubber drain (wrapped with gauze) is laid over the sutured portion of the pancreas and its free end is brought outside the abdominal cavity through the abdominal incision Some surgeons close the anterior abdominal wall and prefer to drain the pancreas through a posterior incision

VII OPERATIONS FOR PANCREATIC TUMORS

Pancreatic tumors are subdivided into

A Benign tumors

B Malignant tumors

A Benign Tumors

The benign type was formerly considered as an extremely rare variety Haberer, up to 1927, was able to collect from the literature only ten cases, which were either fibroma, fibro adenoma or cystadenoma However, during the last few years several cases have been reported These are of particular interest, since some were associated with symptoms of hyperinsulinism The treatment consists in their removal The operative risk is small They usually give one complication namely a pancreatic fistula of long standing

B Malignant Tumors

Malignant tumors are most commonly encountered among the tumors of the pancreas They are most frequently located in the head (60%), then almost as frequently in the body as in the tail (about 8 per cent in each variety) They occur as a generalized growth involving the entire pancreas in 24 per cent

The incidence of cancer of the pancreas is approximately two per cent of the entire number of cancer cases met in the human

Treatment

This is

a Palliative

b. Radical.

a. Palliative Treatment.

This consists in relieving the obstruction of the bile-flow by performing some kind of side-tracking operation, such as cholecysto-gastrostomy or cholecysto-enterostomy. [Cholecystostomy is not advisable, since it will permanently drain the bile outside the body.] Although it is only a palliative procedure, nevertheless it is advisable to perform it, since it relieves such symptoms as itching, which greatly aggravates the suffering of the patient.

b. Radical Treatment.

This consists in removing the tumor with the surrounding portion of the pancreas, or in the performance of a partial or subtotal pancreatectomy with or without the removal of the second and third portions of the duodenum. In the case of carcinoma of the tail or of the body, partial pancreatectomy is feasible, whereas in the case of carcinoma of the head the operation is extremely difficult [since it is necessary, in order to remove the head of the pancreas, to remove the second and part of the third portion of the duodenum, to cut the common bile-duct, the pancreatic and the accessory pancreatio ducts, to perform gastro-jejunostomy, to implant the bile-duct and the pancreatic ducts into the bowel with the possible dangers resulting from leakage of biliary, intestinal and pancreatic juices]. However, several cases of nearly total (subtotal) pancreatectomy have been reported, which shows that as difficult as the technic is, it is still possible, and that a very small portion of the pancreas will produce enough external and internal secretion to satisfy the needs of the body.

During the last few years several cases of adenoma of the islands of Langerhans have been reported, which have been clinically manifested by symptoms of hyperinsulinism. Removal of the adenoma with a small portion of the surrounding tissue in some cases alleviated, and in others entirely cured, the condition.

TECHNIC OF PANCREO-DUODENECTOMY

Step 1. The abdomen is opened by a midline incisioo.

Step 2. Mobilization of the duodenum by the Kocher method, with the difference only that the separation of the duodenum from behind is continued until this howel is detached from the vena cava and the superior mesenteric vessels are reached.

Step 3. Ligation of the right gastric and of the gastroduodenal arteries and also of the gastrocolic ligament.

Step 4. The pylorus is cut between two clamps and the pyloric end of the stomach is closed. The common bile-duct is divided close to the pancreas, if we wish to use this duct for reëstablishiog the communication

between the biliary and the intestinal passages and far away from the pancreas if the gall bladder is used for this purpose

Step 5 The duodenum is now attached only to the upper leaflet of the transverse mesocolon from which it must now be carefully separated Then the duodenum is carefully and gently separated from the superior

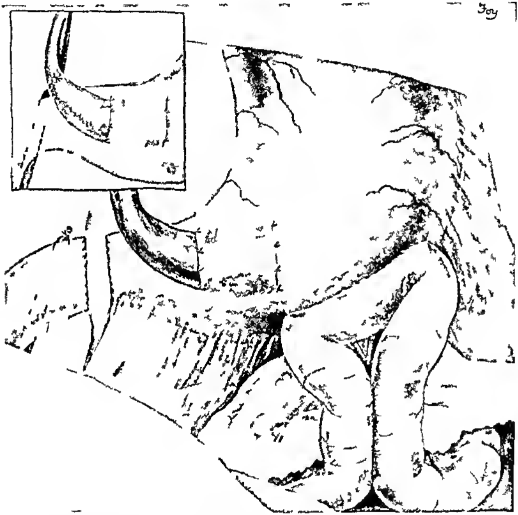

FIG 309 Pancreo-duodenectomy (Spivack technic) *Insert*—Subserous cholecystogastrostomy was done the common bile-duct is cut and two ends of it are ligated *Main picture*—Anterior gastroenterostomy with entero-anastomosis is made Pyloroduodenal junction is cut and two ends closed

mesenteric artery and vein, which lie in front of the duodenum between the pars uncinatum of the pancreas and the duodeno-jejunal junction

Step 6 The duodenum is cut at the duodeno-jejunal junction between two clamps placed immediately to the left of the superior mesenteric vessels

Step 7. The pancreas is cut between two clamps. The duodenum and the head of the pancreas are thus entirely free and are removed from the abdomen.

Step 8. The common bile-duct is implanted into the stomach or jejunum.

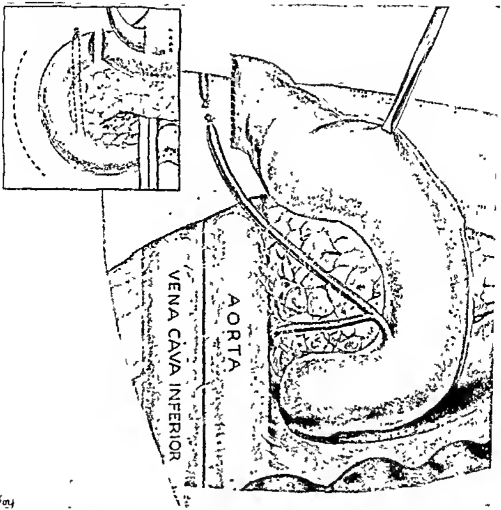

FIG 310 Pancreo-duodenectomy (Spivack technic) *Insert*—Mobilization of the second portion of the duodenum *Main picture*—The second portion of the duodenum is reflected

Step 9. The hemorrhage from the cut surface of the pancreas is checked by sutures. Wirsung's duct is separated from the pancreatic tissue for at least 2 to 3 cm., and is then implanted into the duodeno-jejunal junction. If it is impossible to implant it separately, then the entire stump of the pancreas is invaginated into the duodeno-jejunal opening. Otherwise, the open duodeno-jejunal end is closed.

Step 10. Posterior gastro-jejunostomy is performed.

Due to the magnitude of this operation it is best to perform it in two or even in three stages.

In case of a three-stage method, the steps of the operation are:

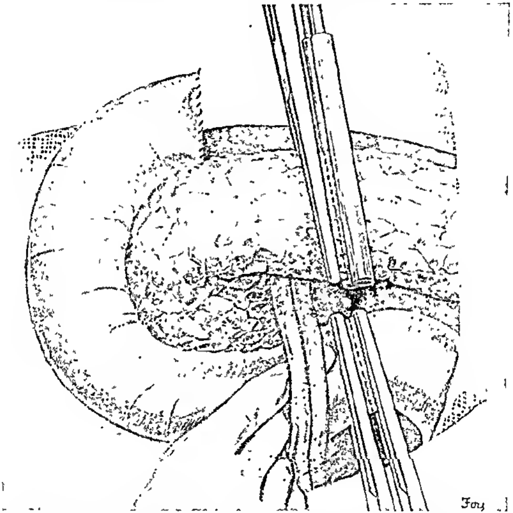

FIG. 311. Pancreo-duodenectomy (Spivack technic). The duodenum is separated from the superior mesenteric vessels; the third portion of the duodenum is clamped by a pair of arterial forceps and the duodenum is cut between them. The body of the pancreas is clamped by two intestinal clamps and the pancreas is cut between them.

SPIVACK TECHNIC

Stage I.

Step 1. The abdomen is opened by a transverse right transrectus incision at a level of one inch above the umbilicus.

Step 2. A subserous cholecysto-gastrostomy is performed in the man-

ner described above (Figs. 274, 275, 276). The supra-duodenal portion of the common bile-duct is ligated just above the duodenum and cut between the ligatures (Fig. 309). The abdomen is closed.

One week later, the second stage is performed.

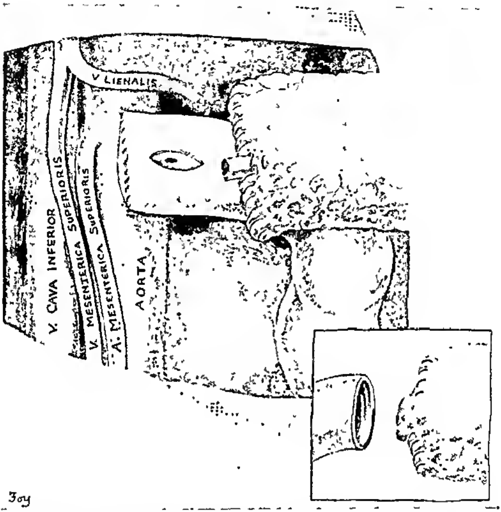

FIG 312 Pancreo-duodenectomy (Spivack technic). *Main picture*—Implantation of the pancreatic duct into the wall of the third portion of the duodenum. *Insert*—Alternate method of inserting the stump of the remaining portion of the pancreas into the third portion of the duodenum.

Stage II.

Step 1. The abdomen is reopened through the incision made in the first stage. This incision is enlarged to the left by cutting transversely the left m. rectus.

Step 2. The right gastric and the right gastro-epiploic arteries are ligated in the manner already described.

Step 3 The pyloro duodenal junction is cut The duodenal and the stomach ends are closed (Fig 309) An anterior gastro jejunostomy is performed, supplemented by an entero anastomosis (Fig 309)

One week later, the third stage is performed

Stage III

Step 1 The abdomen is reopened

Step 2 The gastrocolic ligament is divided and the colon transversus drawn downward The duodenum is mobilized by the Kocher method However this mobilization affects not only the second portion but also the third portion of the duodenum that is it reaches the duodeno jejunal junction (Fig 310) The duodenum should be carefully separated from the superior mesenteric artery and vein, which lie in front of the duodenum between the pars uncinatum of the pancreas and the duodeno jejunal junction

Step 3 The duodenum is cut at the duodeno jejunal junction between two crushing clamps

Step 4 The pancreas is cut between two clamps (Fig 311) Thus the duodenum and the head of the pancreas are entirely separated from the other abdominal viscera

Step 5 The hemorrhage from the cut surface of the pancreas is checked by sutures Wirsung s duct is separated from the pancreatic tissue for at least 2 or 3 cm and is then subserously implanted into the jejunum close to the point of the former duodeno jejunal junction (Fig 312) However if it is impossible to isolate Wirsung s duct or to implant the isolated duct then the entire stump of the pancreas is invaginated into the duodeno jejunal opening which up to this time was not sutured (Fig 312 insert)

Step 6 The clamped end of the jejunum at the duodeno-jejunal junction is now closed (unless it was closed already in Step 5)

Step 7 The abdomen is closed

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PART V

CHAPTER XXIV

HERNIA

Definition.

The word "hernia," as used in modern surgical literature, is derived from the Greek "ἔρνος," which means "a projection." It signifies a protrusion of a viscus through a congenital or an acquired opening of the wall surrounding the corresponding cavity.

In former times authors preferred to use the word "cele," which is a latinized Greek word "kele" (κήλη), "a swelling," and which was used as a suffix of the word designating the contents of the hernia, as enterocele (intestinal hernia), omphalocele (umbilical hernia), etc.

Nomenclature.

The name given to a definite type of hernia either designates its contents, its location, its etiology, or its condition.

1. According to its contents, herniæ are designated as hernia of the small bowel, hernia of the large bowel, etc.
2. According to its location, herniæ are inguinal, femoral, umbilical, diaphragmatic, ventral, perineal, etc.
3. According to the etiology, herniæ are congenital, acquired and postoperative.
4. According to their condition, herniæ are reducible or irreducible, strangulated, etc.

A INGUINAL HERNIA

I. SURGICAL ANATOMY OF INGUINAL HERNIA

The inguinal canal is approximately one and one-half inches long. It begins at the abdominal (internal) inguinal ring and ends at the subcutaneous (external) inguinal ring. The abdominal inguinal ring lies about one-fourth of an inch above the middle of Poupart's ligament, and the subcutaneous inguinal ring lies in front of the lateral portion of the pubic bone. When the individual is in the erect posture, the boundaries of the inguinal canal are:

Anterior Wall.

The skin, superficial fascia (Camper's layer, Scarpa's layer), deep fascia (a very thin layer), and the aponeurosis of the external oblique muscle. These layers lie in front of the entire length of the inguinal canal,

whereas the next layer, namely, the internal oblique muscle, lies in front of the lateral third of the inguinal canal only. Thus, we may say, that **the strength of the anterior wall of the inguinal canal diminishes from its lateral to its medial portion.**

Posterior Wall.

The posterior wall of the inguinal canal is formed by the transversalis fascia through the entire length of the canal, by the conjoined tendon in the medial half of the canal, and by the triangular ligament in its most medial portion. Thus, we may say, that **the posterior wall of the inguinal canal also is not of the same strength in its entire length. It is weakest in the lateral portion and strongest in the medial portion.** The strength of the posterior wall is reverse to that of the anterior wall of the inguinal canal. It can be stated that **the mutual relationship of the walls of the inguinal canal is such that where it is the strongest anteriorly, it is weakest posteriorly, and vice versa.**

The roof of the canal is composed of the arched fibers of the internal oblique muscle (which forms also the antero-lateral wall of the inguinal canal) and of the lower border of the transversus abdominis muscle (which usually stops immediately above the abdominal inguinal ring).

The floor consists of the inguinal (Poupart) ligament, and at its inner end, the lacunare ligament (Gimbernat's ligament).

The contents of the inguinal canal are:

In the male: The spermatic cord, the ilio-inguinal nerve and the genital branch of the genitocrural nerve.

In the female: The round ligament of the uterus, the ilio-inguinal nerve and the genital branch of the genitocrural nerve.

The abdominal inguinal ring (Internal ring, O.T.) is an opening in the transversalis fascia. Its radius is about 1 cm. It lies midway between the anterior superior iliac spine and the symphysis pubis, and about one-fourth to one-half of an inch above the inguinal ligament. Its boundaries are the arched fibers of the transversus abdominis muscle—above and laterally, and the inferior epigastric artery and vein—medially. It transmits the spermatic cord in the male and the round ligament of the uterus in the female. From the circumference of the ring a thin funnel-shaped membrane, the internal spermatic fascia (processus infundibuliformis, O.T.), which is a portion of the transversalis fascia, is prolonged on the cord around its entire circumference.

Subcutaneous inguinal ring (External ring, O.T.). This actually is not a ring but a triangular space, the base of which is formed by the crest of the pubis and the two sides (which are called the crura of the ring) by the split aponeurosis of the external oblique muscle. The crus medially is called crus superior, and that which lies more laterally, crus inferior.

The crura join each other at a point which forms the apex of the external inguinal ring. In order that the crura should not separate from each other above the apex of the subcutaneous ring, there are fibers which run in a semicircular manner transversely and which are called the intercolumnar fibers.

The superior crus is broad and flat and is attached to the body of the pubic bone. The inferior crus is attached to the tubercle of the pubic bone. Therefore the subcutaneous inguinal ring lies in front of and medially to the inguinal ligament. Consequently, the contents of an inguinal hernia after they pass through the inguinal canal lie in front of the inguinal (Poupart) ligament.

The inferior epigastric artery takes its origin from the external iliac artery just above the inguinal (Poupart) ligament, and runs in an upward and medial direcion until it reaches the rectus abdominis muscle to which it furnishes its blood-supply. This artery forms with the lateral border of the rectus muscle and with the inner half of the inguinal ligament a triangle —Hesselbach's triangle. This triangle lies chiefly behind that portion of the posterior wall of the inguinal canal which is formed by the falx inguinalis (conjoined tendon, O.T.)

SUBDIVISIONS OF INGUINAL HERNIA

The inguinal herniæ are of two varieties:

A. **Indirect Inguinal Hernia,** in which the sac enters the inguinal canal through the abdominal inguinal ring, traverses the entire length of the inguinal canal and leaves this canal through the subcutaneous inguinal ring. In this variety, the hernial sac lies laterally to the inferior epigastric vessels.

B. **Direct Inguinal Hernia.** In this variety, the sac bulges through Hesselbach's triangle into the lower portion of the inguinal canal and makes its exit through the subcutaneous inguinal ring. The inferior epigastric artery lies lateral to the sac. This type usually has a small sac with a large neck. It occurs generally in adults. It rarely descends into the scrotum.

III. OPERATIVE TREATMENT OF INDIRECT INGUINAL HERNIA

a. BASSINI OPERATION

This was described by E. Bassini in 1883, and modified by him in 1888. The characteristic feature of his technic consists in a high ligation of the sac, reconstruction of the posterior wall of the inguinal canal, and transplantation of the cord.

Technic.

Step 1. The skin-incision is three or four inches long in adults and two to three inches in children. Lying half an inch above the Poupart ligament,

it begins one inch lateral to the middle point of this ligament and runs downward parallel to this ligament until the subcutaneous ring is reached (Fig. 313, insert). After the skin is incised, the superficial circumflex iliac and the superficial epigastric vessels are seen traversing the superficial fascia. They are clamped and cut between the clamps. The opening thus

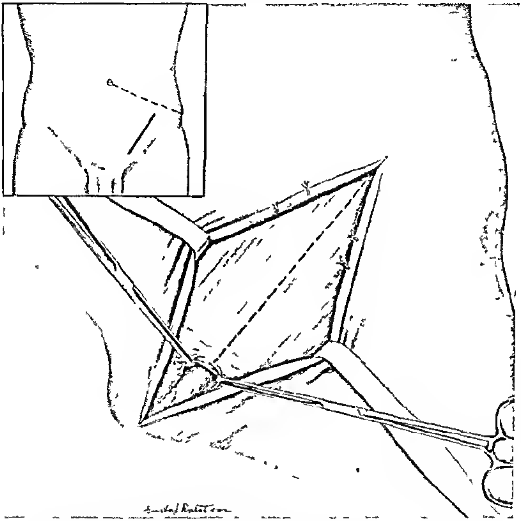
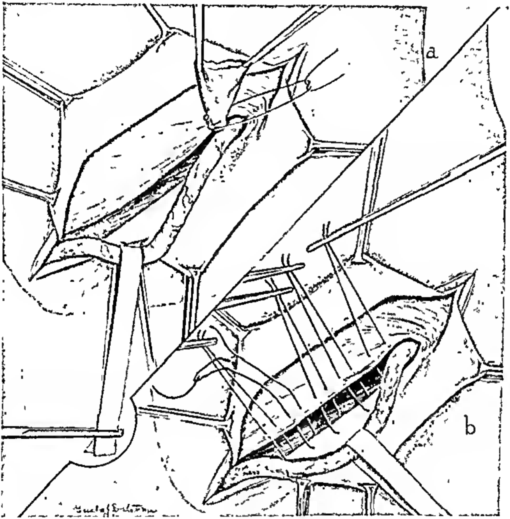


FIG 313 Inguinal herniotomy by the Bassini method *Main picture*—Allis clamps are placed at the upper portion of the external inguinal ring *Insert*—Skin incision

made in the fascia is prolonged by cutting with scissors upward and by a knife downward. The aponeurosis of the external oblique muscle is now exposed. The superficial epigastric and circumflex iliac vessels are ligated and the ends of the ligature cut short (Fig. 313). Skin-towels are now attached to the lips of the wound.

Step 2. The aponeurosis of the external oblique muscle is incised along

the entire length of the skin-incision. This can be done either by cutting it on a grooved director introduced behind the aponeurosis through the external inguinal ring, or by dividing it in the direction from the internal to the external ring. In either case, care should be taken not to injure the



[illegible] method. a, The aponeurosis of the external [illegible]

ilio-inguinal nerve and not to cut the aponeurosis close to Poupart's ligament, since it is desirable to have the lower flap rather wide. Three Allis forceps grasp each aponeurotic lip. One is placed at the upper third of each lip, another at the middle, and the third at the point which forms the arched border of the subcutaneous ring. These lower forceps are used as

landmarks for resuturing the external oblique aponeurosis at the end of the operation (Fig 314 a)

Each lip of the incised aponeurosis is retracted The inner (or upper) lip is retracted for about half an inch, and the lower lip until the shelving portion of the inguinal ligament is exposed down to the spine of the pubic bone

Step 3 Lifting of the cord (round ligament)

The external spermatic fascia is divided along the side of the cord which is then lifted by the finger A tape is placed around the cord [care should be taken not to twist the cord] The free ends of the tape are clamped and held by the assistant (Fig 314, a)

Step 4 Management of the hernial sac

The sac is situated in front of and to the inner side of the cord At this stage of the operation the entire length of the sac is not yet exposed, since the portion of it adjoining the abdominal ring is covered by the lower edge of the *internal oblique muscle Exposure of the sac becomes possible* by making two movements with an ordinary toothed tissue forceps, one, in an upward direction, penetrating the cremasteric muscle (which is a downward prolongation of the internal oblique muscle) and lifting the arcuate fibers of the internal oblique muscle (until the abdominal inguinal ring is reached), and another, by penetrating through the internal spermatic fascia (or infundibuliform fascia, which is a continuation of the transversalis fascia on the cord) in a downward direction The sac is thus exposed, and can be easily recognized by the opaque white convex border of the fundus

The fundus of the sac *is now* grasped by *an* artery-forceps and the *sac* is separated from the cord until its neck is reached It is now opened (care being taken not to injure its contents, if there are any), and its contents are reduced into the peritoneal cavity A transfixing ligature passes through tho neck (Fig 314, a) The ligature is tied and the sac excised, leaving a large stump which is allowed to drop behind the abdominal ring into the free peritoneal cavity

Step 5 Reconstruction of the inguinal canal

The cord is retracted laterally The internal oblique muscle and the conjoined tendon are sutured to the shelving part of the Poupart ligament *It is very important to insert* the stitch closest to the exit of the cord from the abdominal ring at the right place It should be neither too close to the ring so as not to compress the cord, nor too far from the ring, so as to leave a large open ring through which a new hernia may develop A round full curved needle, threaded with chromic catgut No 2, passes through the internal oblique muscle, and, if possible, through the edge of the transversalis fascia which forms the border of the internal ring,

care being taken not to injure the inferior epigastric vessels. Then the needle passes outward through the shelving portion of the Poupart ligament; the direction of the needle is then reversed and is inserted into the internal oblique muscle; thus, this suture, just the same as the rest, is of a

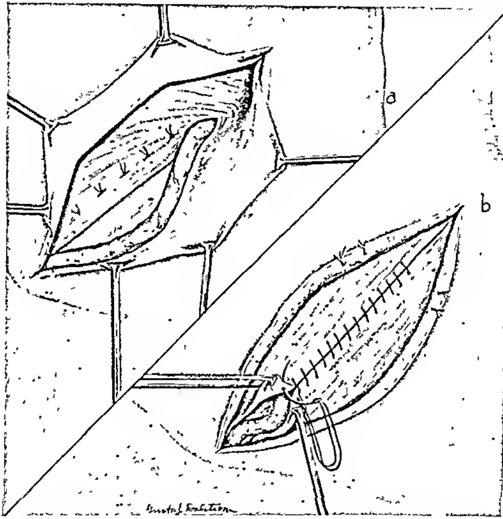


FIG. 315. Inguinal herniotomy by the Bassini method. a. The posterior wall is reconstructed. b. The cord is laid on the newly formed floor and the anterior wall of the canal is reconstructed.

mattress type. [Care should be taken when making the bite through the shelving portion of the Poupart ligament not to injure the femoral or the external iliac artery, which passes behind the ligament at this point—the "femoral point."] Before tying this particular suture we should be certain that it does not compress the cord. This can be ascertained on palpation of the cord by noting the pulsation of the internal spermatic artery.

However, this suture is not tied until the remainder of these deep sutures are inserted These sutures similarly constructed and four to five in number, are placed one third of an inch apart (Fig 314, b) The lowermost suture grasps the conjoined tendon in front of the pubic crest, Gimbernat s ligament (particularly in large herniæ), and Poupart's ligament The sutures are now tied and the ends are cut short (Fig 315, a)

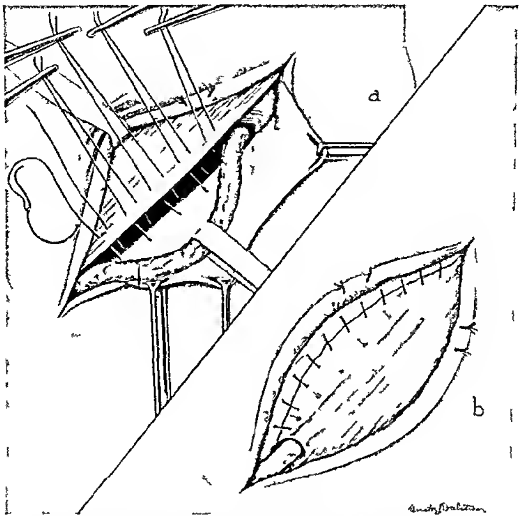


FIG 316 Inguinal herniotomy by the Andrews method a Reconstruction of the posterior wall of the canal b The lower flap is sutured over the cord to the anterior surface of the upper flap

Step 6 The cord is now placed on the newly formed posterior wall of the canal, and the anterior wall is reconstructed by suturing the anterior lips of the aponeurosis of the external oblique muscle to each other with chromic catgut No 1 The lower end of this anterior wall is readily recog-

nized, since two clamps were placed there at the beginning of the operation (one at each side), when the aponeurosis of the external oblique muscle was incised (Fig. 315, b). [Care should be taken when inserting the lowermost suture in the anterior wall not to compress the cord.] The skin is closed by interrupted suture of horse-hair or dermol.

b. ANDREWS IMBRICATION OR "LAP-JOINT" METHOD

This method was described by E. Wyllys Andrews, of Chicago, in 1895.

It carries the essential elements of the Bassini operation (high ligation of the sac, reconstruction of the posterior wall of the inguinal canal, preservation of the obliquity of the canal), and, as an additional feature, it gives a reinforcement of the anterior wall of the canal by overlapping the upper flap by the lower flap of the aponeurosis of the external oblique muscle.

Technic.

Steps 1 to 4 are precisely the same as in the Bassini method.

Step 5 is the same as in the Bassini method, with this difference, that not only the internal oblique muscle and the conjoined tendon but also the aponeurosis of the external oblique muscle are sutured to the shelving portion of the Poupart ligament (Fig. 316, a).

Step 6. The lower lip of the aponeurosis of the external oblique muscle is sutured over the cord to the anterior surface of the upper lip of this aponeurosis (Fig. 316, b).

c. FERGUSON METHOD

This operation is similar to the Bassini operation in the steps which deal with the making of the skin-incision, the opening of the inguinal canal, the lifting of the cord, and the management of the sac. The difference between these two methods is, that whereas in the Bassini method the cord is transplanted, in the Ferguson method it lies in its original position.

Technic.

Steps 1 to 4. As steps 1 to 4 in the Bassini operation.

Step 5. The cord is replaced in its original position. A series of interrupted sutures half an inch apart are inserted, uniting the internal oblique muscle and the conjoined tendon to the shelving portion of the Poupart ligament.

Step 6. The edges of the aponeurosis of the external oblique muscle are sutured to each other.

d POSTEMPSKI S MODIFICATION OF THE BASSINI OPERATION

This method was employed by Postempski, of Rome in 1884, and published in 1890

The operation is a typical Bassini operation up to the point when the hernial sac is ligated Then the cord is lifted, and the inner lip (that is, the internal oblique muscle, the conjoined tendon and the aponeurosis of the external oblique muscle) is sutured to the shelving portion of the Poupart ligament Postempski closes the external ring, thus obliterating entirely the inguinal canal The cord is laid behind the skin and the superficial fascia

IV OPERATIVE TREATMENT OF DIRECT INGUINAL HERNIA

This type of hernia gives a high percentage of recurrence variously estimated by different surgeons as between 5 and 20 per cent The reason for this high percentage of recurrence lies in the fact, that whereas in indirect inguinal hernia the trouble is the weakening of the fascia at the place where the blood vessels (internal spermatic) pass through it while the surrounding structures (transversalis fascia and the muscles) are not altered in this variety that is not the case The entire transversalis fascia in this region is weakened, and sewing it will not make it any stronger The only hope for preventing a recurrence of this type of hernia is to reinforce the weakened structures lying in front of the hernial protrusion by the strong muscles in the immediate vicinity And as a strong muscle is only one factor (and not the most important) in the prevention of hernia formation, the other being a strong fascia (which in this case is weak and cannot be replaced by a strong transversalis fascia), it is evident that recurrences may occur quite frequently in the treatment of a direct hernia

DOWNES TECHNIC

This was described in 1911 It is a further improvement of the Bloodgood method which was described in 1898

Step 1 The skin incision is the same as in the Bassini operation

Step 2 The incising of the aponeurosis of the external oblique muscle, the retracting of the arcuate fibers of the internal oblique muscle, the cutting of the cremasteric muscle and fascia, and the exposure of the sac are the same as in the Bassini operation The sac is incised at its upper end (in order to keep away as far as possible from the urinary bladder) a finger is introduced into its lumen, the sac is isolated from the surrounding structures, and is ligated by a transfixion suture flush with the opening in the transversalis fascia, and then is cut off The lips of the transversalis fascia are sutured if possible, to each other as in an ordinary laparotomy closure

Step 3. Reconstruction of the posterior wall.

The sheath of the rectus abdominis muscle is cut along its lateral margin from the level of the abdominal inguinal ring down to its attachment to the pubic bone. *Three or four chromic or kangaroo sutures,* inserted at a distance of one-half to three-fourths of an inch from each other,

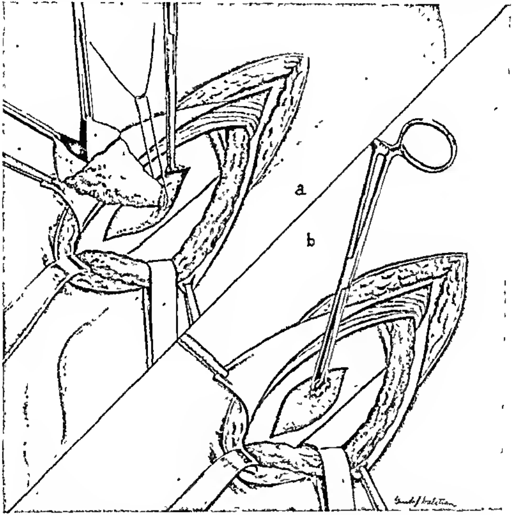


FIG. 317. Direct inguinal herniotomy. a. The neck of the sac is ligated by a transfixing suture. b. The stump of the sac is held by an Allis forceps in order to facilitate its invagination.

unite the lateral margin of the rectus muscle with the shelving portion of Poupart's ligament. [If the transversalis fascia was not sutured as a separate layer, it is now caught in the bites of the rectus muscle.] The internal oblique muscle and the conjoined tendon are sutured to Poupart's ligament superficial to the previously inserted deep sutures, precisely as in the Bassini operation. The cord is laid on this newly formed posterior wall.

Step 4. The lips of the aponeurosis of the external oblique muscle are sutured to each other either as in the Bassini operation or as in the Andrews imbrication method.

Another method of treatment of a direct inguinal hernia is as follows:

Step 1. The incision of the skin, fascia and aponeurosis of the external

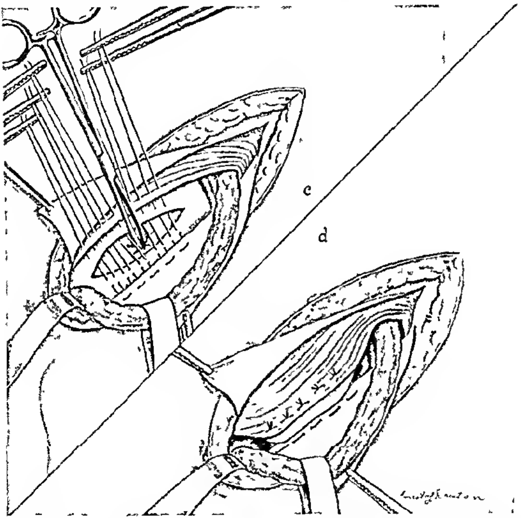


FIG 318 Direct inguinal herniotomy c Mattress sutures are inserted, d The mattress-sutures are tied, thus bringing the internal oblique muscle and the transversalis fascia to the shelving portion of the Poupart ligament

oblique muscle, and the lifting of the spermatic cord, are the same as in the Bassini operation

Step 2. The transversalis fascia is incised, the sac is isolated, and its neck is closed by a transfixion-suture (Fig. 317, a). The sac is cut off distal to the ligature, and the stump is held by an Allis forceps in order to facilitate its invagination in the next step of the operation (Fig. 317, b).

Step 3. A number of mattress-sutures are inserted uniting on the inner lip the internal oblique muscle with the transversalis fascia (in the upper portion of the wound) and the conjoined tendon with the transversalis fascia (in the lower portion of the wound) with the shelving portion of

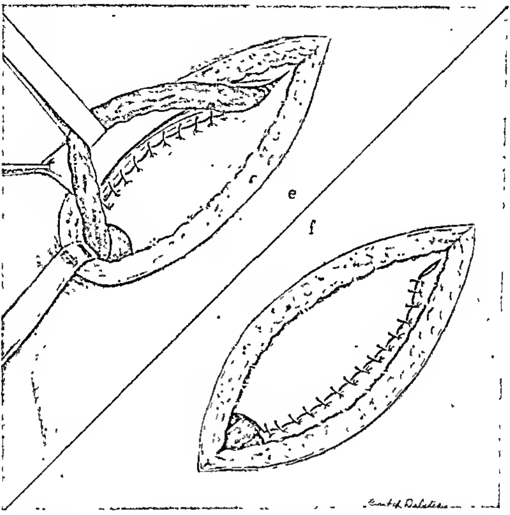


Fig. 319. Direct inguinal herniotomy. e. The lateral flap of the aponeurosis of the external oblique muscle is sutured over the anterior surface of the internal oblique muscle and conjoined tendon. f. The medial flap of the aponeurosis of the external oblique muscle covers the cord and is sutured to the anterior surface of the Poupart ligament.

Poupart's ligament of the outer lip (Fig. 318, c). The ends of each thread are tied to each other (Fig. 318, d).

Step 4. The reconstructed wall is reinforced by suturing the edges of the lower (lateral) flap of the aponeurosis of the external oblique muscle to the anterior surface of the internal oblique muscle (Fig. 319, e). The cord is placed on the newly formed floor. The upper lip of the aponeurosis

of the external oblique muscle is sutured over the cord to the anterior surface of the lower lip of the aponeurosis of the external oblique muscle (Fig. 319, f).

Step 5. The skin is closed.

V. OPERATIVE TREATMENT OF CO-EXISTENT DIRECT AND INDIRECT HERNIA (PANTALOON HERNIA)

Hoguet Method.

This was described in 1920. The characteristic features of this operation consist in:

a. Pulling the portion of the sac which forms the direct inguinal hernia lateral to the *deep epigastric vessels*, *thus transforming* the *direct* and indirect portions of the sac into one sac lying lateral to these vessels.

b. Suturing a duplicated portion of the aponeurosis of the external oblique muscle to the shelving portion of the Poupart ligament.

Technic.

Steps 1 and 3. The incision of the skin and of the aponeurosis of the external oblique muscle and the lifting of the cord are precisely the same as in Steps 1 to 3 of the Bassini operation.

Step 4. The management of the sac.

The sac is exposed. That portion of it lying lateral to the deep epigastric vessels is grasped and pulled laterally. This will draw laterally the direct portion of the sac, thus transforming a pantaloon hernia into an oblique inguinal hernia. [If the blood-vessels are in the way, it is best to divide them between ligatures, although in the majarity of cases this is not necessary.] The sac is now handled as in the Bassini operation.

Step 5. Reconstruction of the floor of the inguinal canal.

The inner lip of the aponeurosis of the external oblique muscle is reflected in such a manner that along the line of reflection a duplication is formed half an inch wide. This duplicated aponeurosis together with the internal oblique muscle and conjoined tendon are sutured to the shelving portion of the Poupart ligament by a series of interrupted mattress-sutures lying half an inch apart.

Step 6. As in the Bassini operation.

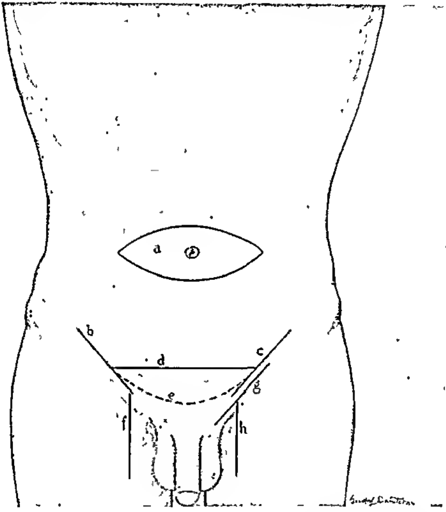
VI. TRANSVERSE INCISION FOR DOUBLE INGUINAL HERNIA OPERATION

a. Edmunds Incision (Fig. 320, e).

This was suggested in 1908.

The incision starts at a point midway between the abdominal and subcutaneous inguinal rings on one side and extends in a slightly curved manner to the symmetrical point of the opposite side. It runs within the

pubic hair approximately one inch above the symphysis pubis. This incision gives a good exposure for the management either of a direct or of an indirect inguinal hernia. It leaves a scarcely noticeable scar, and for this reason is particularly suitable for operations on unmarried women.



[illegible] ilical herniotomy by the [illegible] bilateral inguinal herni- [illegible] and h. Skin-incision for

b. Judd Transverse Incision (Fig. 320, d).

This was described in 1913.

This incision starts at a point midway between the abdominal and subcutaneous inguinal rings on one side and runs straight across the anterior abdominal wall until it reaches the symmetrical point of the opposite side.

VII OPERATIVE TREATMENT OF INGUINAL HERNIA AND UNDESCENDED TESTIS

The undescended testis may be found either in the abdominal cavity, in the inguinal canal, or below the external ring If it is found at the internal ring, it may be difficult to bring it down and for this reason it is advisable either to slip it back into the abdominal cavity (which is done by the majority of surgeons) or to remove it entirely (which is not recommended) In case it is decided to place it in the abdominal cavity, some surgeons advise making a pocket in the wall of the small pelvis and placing it there However, an attempt should always be made to lodge it in the scrotum, since in the majority of cases this is feasible

As this condition usually comes to the attention of the surgeon while the patient is very young, it becomes a problem at what age to operate The majority of surgeons still think that the best time to operate is about the age of fifteen, that is, immediately following puberty However, in the recent work of many investigators it was definitely proved that if we wait until puberty the patients remain sterile, whereas in case of early operation the testicle is preserved as a reproductive organ, and for this reason we believe the best time to operate is between the ages of six and nine years Of the numerous methods suggested the most commonly used is that of A D Bevan, described in 1899

a BEVAN METHOD

If the undescended testicle has not reached the inguinal canal, the occurrence of a coexisting hernia is a rare coincidence However, if the testicle lies in the inguinal canal, a coexisting hernia is present in 50 per cent of the cases Therefore, at least in 50 per cent the operation consists not only of making a new domicile for the testicle but also in performing a herniotomy

The principle of this operation is based on the fact that if the spermatic cord is freed from its coverings so that the testis hangs only on the vas deferens and the spermatic vessels, the cord becomes elongated and the testicle can be placed several inches below the previous lowermost position

Technic

Step 1. The skin is incised as in inguinal herniotomy The aponeurosis of the external oblique muscle is split The testicle is lifted from the bed of the inguinal canal The vaginal process (the sac) is carefully separated from the cord, ligated high, cut distal to the ligature, and the stump dropped into the peritoneal cavity All the coverings of the cord are now removed, leaving the testicle hanging only on the vas and spermatic vessels Now the testis can readily be brought down for a distance of from two to three inches

Step 2. A pocket is made in the scrotum for the reception of the testis, care being taken to make it just as large as is necessary for it to retain the testis. The testis is not sutured to the scrotum in order to avoid any complications.

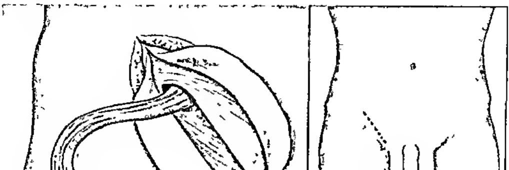


FIG. 321. Orchidopexy by the Keetley-McKenna method *Insert*—Skin-incision in the inguinal region, scrotum and thigh. *Main picture*—The lateral lip of the scrotal and the inner lip of the femoral skin incisions are sutured together.

Step 3. The walls of the inguinal canal are reconstructed according to any of the recognized methods of treatment of an inguinal hernia.

b. KEETLEY-McKENNA METHOD

Keetley, in 1894, suggested keeping the undescended testicle attached to the thigh after the cord has been elongated. In his earliest work, he

sutured the tunica albuginea of the testicle to the fascia lata and kept it there for from three to six months, after which he detached it, and let it remain in the scrotum Later, he discarded this method, and suggested (in 1905) another method in which he sutured the gubernaculum Hunteri

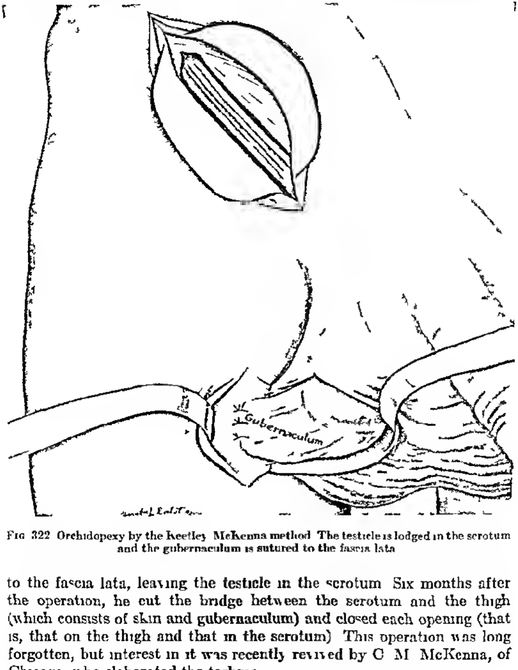


FIG 322 Orchidopexy by the Keetley McKenna method The testicle is lodged in the scrotum and the gubernaculum is sutured to the fascia lata

to the fascia lata, leaving the testicle in the scrotum Six months after the operation, he cut the bridge between the scrotum and the thigh (which consists of skin and gubernaculum) and closed each opening (that is, that on the thigh and that in the scrotum) This operation was long forgotten, but interest in it was recently revived by C M McKenna, of Chicago, who elaborated the technic

Technic.

Step 1. Skin-incision as in inguinal herniotomy (Fig. 321, insert).

Step 2. The testicle and the cord are lifted from their bed. They are freed from everything but the musculo-fibrous bands forming the gubernaculum. The gubernaculum is cut as far as possible from the testicle [Lucas Championnière showed that by freeing the cord from all connective tissue and leaving it hanging only on the vas deferens and the spermatic vessels, the cord becomes elongated to such an extent that the testicle can be brought from two to three inches lower than before, an observation which was utilized by Bevan in his method of treatment of undescended testis and by Keetley in his method of orchidopexy] (Fig. 321).

Step 3. The scrotum is stretched by two fingers introduced into it, in order to give sufficient room in which to lodge the testicle. A small incision, one and one-half inches long is made on the bottom of the scrotum and another incision of the same length is made on the thigh at the same level (Fig. 321 insert).

Step 4. The adjoining lips of the incisions made on the scrotum and the thigh are sutured to each other (Fig. 321).

Step 5. An artery forceps, passing through the scrotum from below upward, grasps the gubernaculum and carries it with the testis through the scrotum until the gubernaculum is lodged on the fascia lata of the thigh. The testicle remains in the scrotum. The gubernaculum is now sutured to the fascia lata (Fig 322).

Step 6. The lateral cutaneous lip on the thigh is sutured to the lip of the scrotum, thus closing both openings (on the thigh and on the scrotum).

Two months later, the cutaneous bridge which connects the thigh with the scrotum is cut under local anesthesia. The two lips of the skin of the thigh are sutured to each other. The same is done with the edges on the scrotum.

Franz Torek, of New York, in 1909, suggested suturing the testicle to the fascia lata. He considered this an improvement in the method of suturing the gubernaculum. However, as mentioned already, this method of Torek is actually one of the oldest variations used by Keetley, which he later discarded for his "gubernaculum-method."

VIII. SLIDING HERNIA

This variety of hernia of the large bowel was first described by Scarpa. However, it did not attract the attention of the profession until the beginning of this century, when the French surgeons again called attention to it.

Not every hernia of the large bowel is a "sliding hernia." The conditions are not synonymous by any means. However, in some cases, hernia of

the large bowel may become a "sliding hernia" It is difficult to give the definition of the term in a few words For this reason, it will be necessary to define it in a more descriptive manner

When a structure such as the small bowel, the transverse colon, or the sigmoid leaves the abdominal cavity and enters the inguinal (or the femoral) canal, it becomes the content of an ordinary hernial sac However, if the ascending or the descending colon, which is not completely invested by visceral peritoneum, becomes dislodged and begins to move in a downward direction in such a manner that its peritoneum, which covers it in front and at the sides, remains immobile, while the bowel itself slides down until it appears in the inguinal (or femoral) canal, then it becomes a "sliding hernia" This bowel may be the entire content of the canal, and in such a case, there is no sac present, this is a sacless type of hernia Or, the protruded part of the bowel may be only a part of the contents of the inguinal canal, the rest consisting of the usual peritoneal sac, the contents of which are any abdominal viscera which ordinarily may be in the hernial sac In this variety the sliding bowel lies behind the posterior wall of the sac

From this description it is clear that any of the abdominal viscera which are completely surrounded by peritoneum, cannot become (under ordinary circumstances) a part of the sliding hernia Only structures which are invested by the peritoneum in front, or in front and at the sides, can become the contents of the sliding hernia

An abdominal viscus completely surrounded by peritoneum which forms a mesentery may become a part of a sliding hernia only under such an unusual circumstance as when the two leaflets of the mesentery begin to separate from each other and the mesenteric border of the bowel loosens from its attachment to the mesentery Then the bowel begins to slide whereas the leaflets of the mesentery remain immobile

The operative technic varies, depending on whether we deal with the small sacless hernia ("pushing" variety of Moschcowitz) or with sliding hernia with a sac ("pulling" variety of Moschcowitz)

The technic of operation in the "pushing" variety is as follows

Step 1 The skin incision is made as in ordinary inguinal herniotomy The skin, the fascia, the aponeurosis of the external oblique muscle are incised The cord is lifted, and the cremasteric muscle and the lower edge of the internal oblique muscle are retracted upward The projecting portion of the bowel is pushed back into the retroperitoneal space If there is difficulty in doing this, some blunt dissection will help

Step 2 Deep sutures are placed connecting the internal oblique muscle and the transversalis fascia of the inner lip to the shelving portion of the Poupart ligament, care being taken to hold the replaced bowel in position

until the deep sutures are tied. The rest of the operation is the same as described in inguinal herniotomy.

The technic of operation in the "pulling" variety is as follows:

Step 1. The incision through the skin, superficial fascia and aponeurosis of the external oblique muscle, the retraction of the aponeurotic lip, and exposure of the hernial sac, are precisely the same as in the Bassini operation.

Step 2. The sac is opened and its contents reduced into the free peritoneal cavity. All but the sliding portion of the bowel is easily reduced. This portion of the bowel refuses to budge [this itself should make the surgeon suspect that it is probably a "sliding hernia." If he sees appendices epiploicæ or tænia longitudinalis coli, then he will be sure that he is dealing with a piece of large bowel, *i.e.* he is confronted with a "sliding hernia."] The sac is carefully separated from the cord until the internal ring is reached. The sac together with the herniated bowel are lifted from the posterior wall of the hernial space. The liberation of the sac should start and continue from the other side. This will minimize the possibility of injury to the blood-vessels of the bowel.

Step 3. The intestines and the sac (the invaginated posterior wall thereof) are lifted so as to put the bowel-attachment to the posterior wall on a moderate stretch. Then it will be seen that the posterior wall of the sac drops down over the nutrient blood-vessels of the bowel. The posterior wall of the sac is now incised longitudinally in two places, and the flap thus formed is sutured here and there to the stretched peritoneum, so that some sort of a mesentery is formed. The bowel now is entirely liberated from the sac and is reduced without any difficulty. The remnants of the sac are ligated at the internal ring and cut off.

Step 4. The canal is repaired by any of the methods hitherto described

ALTERNATIVE METHOD OF TREATING A SLIDING HERNIA (LARDENNOIS METHOD)

Step 1. As Step 1 in the previous operation.

Step 2. The abdomen is opened, the hernia contents of the sac are reduced, the sliding portion of the bowel is corrected. Colopexy is done by suturing the wall of the bowel to the parietal peritoneum of the posterior abdominal wall. The sac is dislodged from its bed in the hernial canal from within the abdominal cavity and extirpated.

Step 3. The abdomen is closed in layers.

Step 4. The inguinal canal is repaired in the usual manner.

ADDITIONAL REMARKS

As suture-material the majority of surgeons use chromic catgut No. 2 for reconstruction of the posterior wall of the inguinal canal and No. 1

for the anterior wall Very few now use kangaroo-tendon Recently there has been revived an interest in "living-sutures" as suture-material This was suggested by L L McArthur as long ago as 1901, and was used quite extensively for some time With the improved methods of sterilization of suture-material this method was employed less and less frequently The reason for the revival of the interest in it in recent times is that it is claimed by some investigators that the strips of aponeurosis of the external oblique muscle connected with the mother-ground will live indefinitely, so that no foreign-body is present and no absorption of suture material takes place However, very few surgeons use "living sutures" for repair of inguinal or femoral hernia

In recent years, several clinics reported a series of cases of inguinal hernia successfully treated by the injection method The sclerosing material is injected along the course of the inguinal canal starting at the internal ring and gradually approaching the external ring with each subsequent injection This method certainly should be condemned As a matter of fact the method is not new It was used quite extensively in pre-antiseptic days, and as the irritant material, tincture of iodine, infusion of oak bark, zinc chlorid and alcohol were used

Many disastrous reports were then recorded, as peritonitis, sloughing of the abdominal wall, wounding of the intestine, and injection into the femoral artery or vein But whereas there was some excuse in using the injection method in pre-antiseptic days, when opening of the sac was dangerous and when the etiology of hernia was not clear, there is no excuse for its use today It is generally accepted that for radical cure of an inguinal hernia two facts are essential, namely, high ligation of the sac (which means obliteration of the sac) and reinforcement of the inguinal canal (which is considerably less important than high ligation of the sac) In the injection method the sac is not removed The entire hope lies in the expectation of making a barrier against the downward movement of the abdominal contents For these reasons, we believe that the injection method aside from being dangerous, does not offer any hope for permanent cure and certainly should not be employed.

B FEMORAL HERNIA

Definition.

A femoral hernia is the protrusion of one or more abdominal viscera through the femoral ring into the femoral canal

It occurs more frequently in women than in men, employing the percentage basis of the number of femoral herniæ to the number of inguinal herniæ occurring in each sex However, in absolute numbers it is met more frequently in men than in women since men suffer from hernia more frequently than women

Surgical Anatomy.

The femoral canal is a short, narrow channel, the length of which is about one-half to three-fourths of an inch, and which is situated between the femoral vein and the inner wall of the femoral sheath. It communicates with the abdominal cavity through the femoral ring.

The boundaries of the femoral ring are Poupart's ligament in front, the femoral vein laterally, Gimbernat's ligament (ligamentum lacunare) medially, and the horizontal ramus of the pubic bone, covered by Cooper's ligament and the origin of the pectineus muscle, posteriorly.

The contents of the femoral canal are a few lymph-glands and some fatty tissue. The coverings of the femoral hernia are: The skin, the superficial fascia, the cribriform fascia, the transversalis fascia (femoral sheath), the properitoneal fat and the peritoneum.

Operative Treatment.

Numerous operative procedures have been suggested for the cure of a femoral hernia. It will probably be safe to say that there are described more than eighty different methods. However, all of these can be classed into a few groups. The reason why so many methods were suggested is that the results are not as satisfactory as in the treatment of an inguinal hernia.

As early as 1879, Socin showed the importance of high ligation of the sac. He believed this to be the only important step necessary for a radical cure of a femoral hernia, and many surgeons are of the same opinion. Bassini, DeGarmo, Coley and others suggested making a high ligation of the sac and obliterating the femoral ring by a crural approach. The aim is ideal, since these two requirements (high ligation of the sac and relative closure of the femoral ring) is all that is necessary for the radical cure. However, technically it is extremely difficult to close the femoral ring from below or to produce a real high ligation of the sac. This is the reason why many surgeons prefer to expose the femoral ring through the incision for an inguinal herniotomy and to separate the sac, ligate its neck, extirpate it and close the opening from above. There is no question that this method gives a better approach for the radical cure of a femoral hernia. However, such an approach may produce a postoperative direct inguinal hernia. Therefore, the entire question of approach to the femoral hernia hinges on the consideration as to which will occur more frequently, a marked diminution in the recurrence of a femoral hernia after an inguinal approach, or the increased number of direct inguinal herniæ? On theoretical grounds we consider the inguinal approach the better one. But statistics show that recurrences in either method of approach are about the same. However, in the case of a strangulated femoral hernia the approach from above has many advantages.

a FEMORAL APPROACH (BASSINI OPERATION)

Step 1 A skin incision is begun one half of an inch above Poupart's ligament and runs downward for 3 or 4 inches over the femoral canal parallel to the femoral vessels The falciform edge (Margo falciformis) of the fascia lata is well exposed (Fig 320, f)

Step 2 The cribriform fascia and the transversalis fascia are incised and the sac is grasped and freed from the fat which surrounds it It should be kept in mind that the femoral vein lies immediately lateral to the neck of the sac The sac is freed from beyond the neck where it begins to expand again into the peritoneal cavity It is there transfixed by chromic catgut and ligated The sac is cut off distal to the ligature

Step 3 Obliteration of the femoral canal and ring (Fig 323, a)

Three or four chromic catgut sutures connect the Cooper s ligament with Poupart's ligament, the innermost suture connecting a point of Cooper s ligament near the pubic spine the other about one fourth of an inch more laterally, and the third about one fourth of an inch to the inner side of the femoral vein These three sutures are not yet tied Three or four other sutures are now inserted connecting the edge of the falciform process with Cooper's ligament All the ligatures are now tied, starting first with the upper sutures, connecting Poupart's ligament with Cooper s ligament, and then the lower ones

Step 4 The skin is closed

Instead of using several interrupted sutures, Poupart's ligament and the falciform process may be attached to Cooper s ligament by a purse string suture (Fig 323, b) This is known as the Cushing method, and was described in 1888 The results of this method are identical with that of Bassini

b INGUINAL APPROACH

The inguinal approach for radical cure of a femoral hernia was first carried out by Annandale in 1876 This operation was later described again by Ruggi in 1892, who gave a detailed description of the method In the United States, Moschcowitz called the attention of the profession to the merits of this approach, hence this method is known in this country as the Moschcowitz operation

Technic

Step 1 The skin incision, four inches long is made as for an inguinal herniotomy, with the difference only that the upper end does not reach as high as in the inguinal herniotomy and the lower end reaches further down even to the spine of the pubic bone (Fig 320, g) The aponeurosis of the external oblique muscle is divided The aponeurotic flaps are sepa

rated from the underlying structures, and the spermatic cord (or the round ligament) is exposed and lifted. The upper lip of the aponeurosis of the external oblique muscle, the internal oblique muscle, the conjoined tendon, and the spermatic cord are retracted upward and inward. The lower flap of the aponeurosis of the external oblique muscle is retracted down-

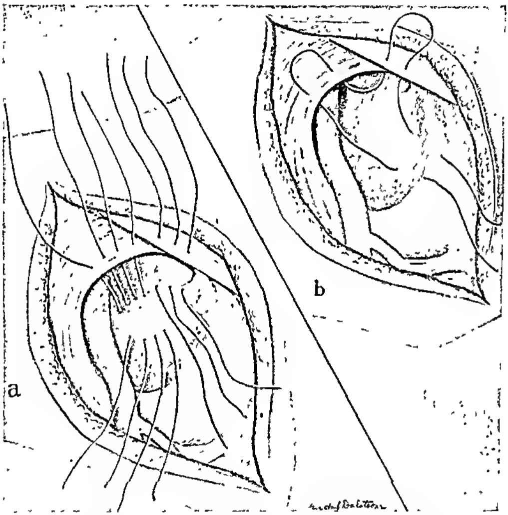


FIG. 323 Femoral herniotomy. a. Bassini method. b. Purse-string method.

ward and laterally (Fig. 324, a). The retraction of these structures will expose the transversalis *fascia which is now cut to the inner side* and parallel to the deep epigastric vessels which are now retracted outward (Fig. 324, a). (If, however, they are in the way, they should be cut between ligatures.) This will expose the peritoneum and its continuation into the neck of the femoral sac.

Step 2. Management of the sac.

The neck of the sac is opened and its contents withdrawn into the free peritoneal cavity. A clamp is then introduced into the femoral sac, and the fundus of it is caught by the same clamp and pulled out from its bed in an everted position (Fig. 324, b). The neck is ligated by a transfixion-

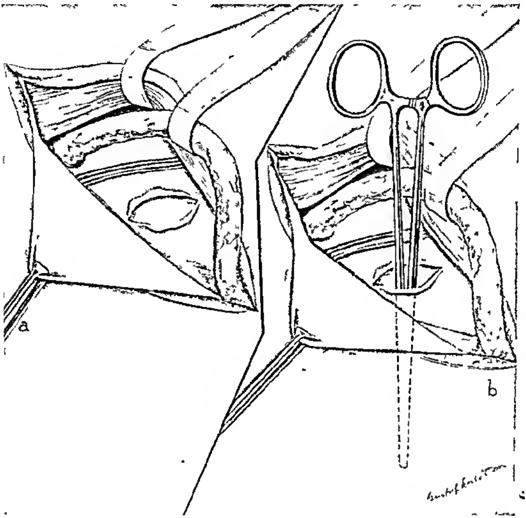


Fig 324 Inguinal approach for femoral herniotomy a The transversalis fascia is cut below the deep epigastric vessels, b The femoral sac is everted by an artery forceps

suture of chromic catgut and cut off distal to the ligature. [If, however, the sac cannot be pulled out in the everted position on account of adhesions between it and its bed in the femoral canal, an additional skin-incision should be made along the course of the femoral canal (Fig. 320, b), and the sac exposed and separated from its bed.]

Step 3. Closure of the femoral opening.

A chromic catgut No. 3, or a Pagenstecher celloidin linen thread No. 3, attaches Cooper's ligament to Poupart's ligament immediately medial to the femoral vein. Two or three additional sutures are placed in a similar manner medial to the first, the last one grasping also Gimbernat's ligament (ligamentum lacunare). The lips of the incised transversalis fascia are included in all these bites. The ends are tied only after all the sutures have been inserted. Another layer of sutures is inserted connecting the internal oblique muscle, the conjoined tendon and the aponeurosis of the external oblique muscle with the Poupart ligament in a line just lateral to the previously inserted deep sutures. The cord (or the round ligament) is now laid on the newly formed floor of the inguinal canal. The lower lip of the aponeurosis of the external oblique muscle is then sutured over the cord (round ligament) to the anterior surface of the upper lip of the aponeurosis of the external oblique muscle. The skin is closed by metallic clips or by dermal sutures.

C. UMBILICAL HERNIA

Definition.

This is a protrusion of an abdominal viscus through the umbilical ring.

The umbilical hernia is covered by the following structures:

a. Skin.
b. Superficial fascia.
c. Transversalis fascia.
d. Peritoneum.

OPERATIVE TREATMENT OF UMBILICAL HERNIA

There are described various operative methods which differ from each other in the manner of closing the ring after the sac is removed.

a. TRANSVERSE OVERLAPPING METHOD (MAYO METHOD)

Step 1. Skin-incision.

An elliptical transverse incision is made surrounding the umbilicus, the right and the left ends of which reach the semilunar line (linea Spigelii) (Fig. 325, insert). This incision lies at a distance of one inch from the umbilicus, and cuts the skin and fascia, thus exposing the anterior sheaths of the recti muscles. The cutaneo-fascial circular lip around the umbilicus is now reflected centrally until the umbilical ring is reached. The transversalis fascia is cut and the hernial sac is exposed.

Step 2. Management of the sac.

The sac is opened close to the neck. The reason for this is, that the closer the hernial sac is to the umbilical ring the more recent is its origin,

and for this reason fewer adhesions are present and there is less chance of injuring the contents of the sac The neck is now enlarged sufficiently to admit two fingers into the sac in order to ascertain the nature of its contents and whether they are reducible If the contents consist of bowel and omentum which can be easily reduced, this is the best thing to do If

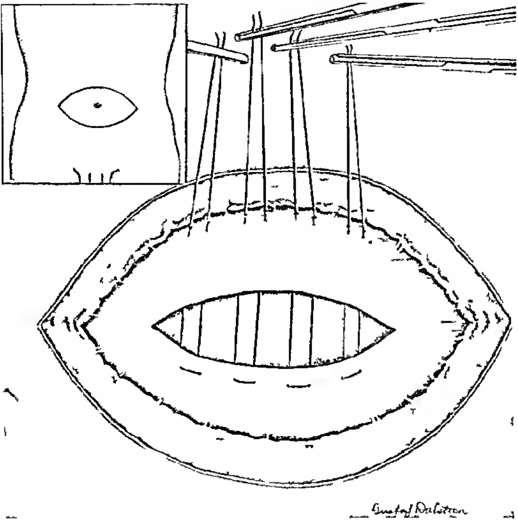


Fig 325 Umbilical herniotomy by the Mayo method *Insert*—Skin incision *Main picture*—A series of interrupted mattress sutures are inserted connecting the upper and the lower aponeurotic flaps

the contents consist of omentum only which is firmly adherent to the sac, it is better to cut away the sac with the omentum, presuming of course, that the omentum has been ligated by a series of transfixion ligatures If loops of bowel are present in the sac, they should be separated from each other and from the sac If it is impossible to separate them from the sac,

it is advisable to incise the sac a small distance away from the bowel so as to leave pieces of the sac hanging on the bowel. If, however, it seems an impossible procedure to separate the loops of the bowel from the sac without numerous injuries it may be preferable to resect the loop, or loops, of bowel.

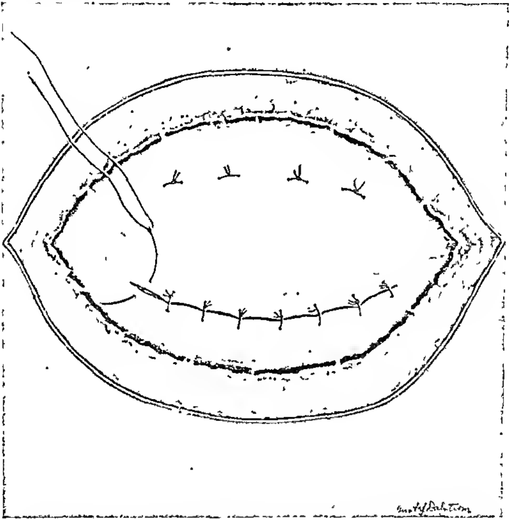


FIG. 326. Umbilical herniotomy by the Mayo method. The lower aponeurotic flap is drawn behind the upper and the mattress-sutures are tied. Suturing of the edge of the upper flap to the lower flap.

After the contents of the sac are disposed of, the neck is ligated by a transfixion-suture, and the stump is dropped into the peritoneal cavity.

Step 3. Closure of the ring.

The anterior sheath of the rectus muscle is cleared from overlying fat above and below the wound for a distance of two inches. A series of mattress-sutures, half an inch apart are inserted in such a manner that

the loops are situated on the lower flap at a distance of half an inch from its margin, whereas the free ends appear on the upper flap at a distance of two inches from its free margin (Fig 325) These sutures do not penetrate the peritoneum The lower flap is now drawn behind the upper flap for

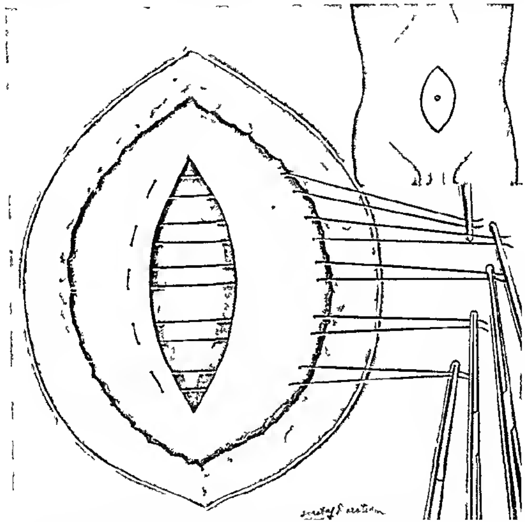


Fig 327 Umbilical herniotomy by the Sapiejko-Piccoli method *Insert*—Skin incision *Main picture*—A series of interrupted mattress sutures are inserted connecting the right and left aponeurotic flaps

at least a distance of two inches, and the mattress sutures are tied The margin of the upper flap is retracted in order to verify whether any gap is left on the suture-line of the two aponeurotic flaps If a gap is present it should be closed by a buttonhole suture The upper flap then covers the lower one, and its free margin is sutured to the anterior surface of the lower flap by a few interrupted sutures (Fig 326) The skin and the superficial fascia are closed by interrupted sutures

b. LATERAL OVERLAPPING OF THE FASCIA (SAPIEJKO-PICCOLI METHOD)

This method has been used by Blake, DeGarmo, Noble and others. It is suitable for very thin subjects. The priority of introducing this method

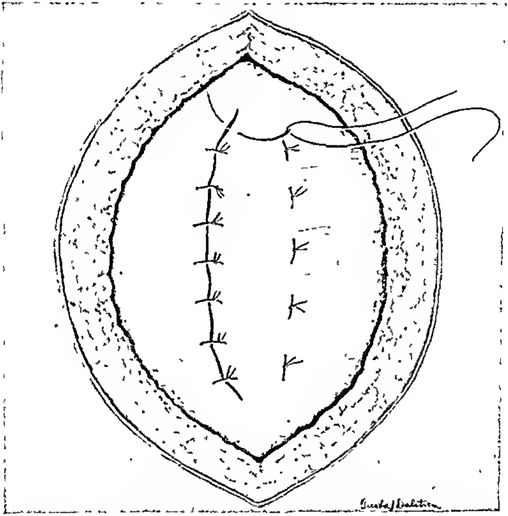


Fig. 328 Umbilical herniotomy by the Sapiejko-Piccoli method The right aponeurotic flap is drawn behind the left flap, the mattress-sutures are tied; suturing the edge of the left aponeurotic lip to the anterior surface of the right lip.

belongs to Sapiejko, who performed it for the first time in 1898, and published it in February, 1900. Independently of Sapiejko, it was described by Piccoli in January, 1900. Thus the priority in reporting belongs to Piccoli and of performing to Sapiejko. In the United States it is known as the Blake method.

TECHNIC OF THE SAPIEJKO PICCOLI METHOD

Step 1 An elliptical incision is made around the umbilicus with its long axis running longitudinally (Fig 327, insert) The skin, fascia, anterior sheath of the rectus muscle and the transversalis fascia are cut and the neck of the sac is exposed and freed around the umbilical ring

Step 2 The management of the sac is the same as in the previous operation

Step 3. The anterior sheaths of the recti muscles are cleared of fat, and a series of interrupted mattress sutures are inserted half an inch apart (Fig 327), so that the anterior sheath on one side is drawn behind the anterior sheath of the other side for a distance of two inches (Fig 328) Then the free inner margin of the superficially placed sheath is sutured to the anterior surface of the sheath which was drawn behind (Fig 328)

Step 4 The skin is closed

c DuBOSE METHOD

This method consists in making two horizontal flaps the edges of which are sutured to each other in the median line, and in covering this layer by another layer of sutures made between the upper and lower flaps It was suggested in 1915

Technic

Step 1. Skin-incision An elliptical incision is made around the umbilical hernia, the long axis of which runs transversely

Step 2 The sac is isolated, the contents removed in the usual manner, and the neck of the sac closed by a purse string suture (Fig 329, a)

Step 3 Two transverse incisions are made, one immediately above and the other immediately below the umbilical ring, cutting the anterior sheath of both recti muscles (Fig 329, b) Thus, two lateral flaps are formed, which are sutured to each other in the midline (Fig 329, c) The upper, and the lower lips of the anterior sheath are then sutured to each other, over the previously made suture line, by a series of interrupted sutures (Fig 329, c) These vertical sutures are now tied and two figure-of-8 sutures are inserted connecting the skin and the superficial fascia of one lip, then the anterior sheath of the rectus muscle in two places, and then the skin and the superficial fascia of the other lip (Fig 329, d)

D VENTRAL HERNIA

Definition.

This is a protrusion of the viscera through some point in the anterior abdominal wall Broadly speaking, the inguinal, femoral and umbilical herniæ are varieties of ventral hernia However, when speaking of a ventral hernia, the inguinal, femoral or umbilical types are excluded

Ventral hernia may be subdivided, from the topographical standpoint, into:

a. Hernia lineæ albæ.

b. Lateral ventral hernia.

From the etiological standpoint it is subdivided into:

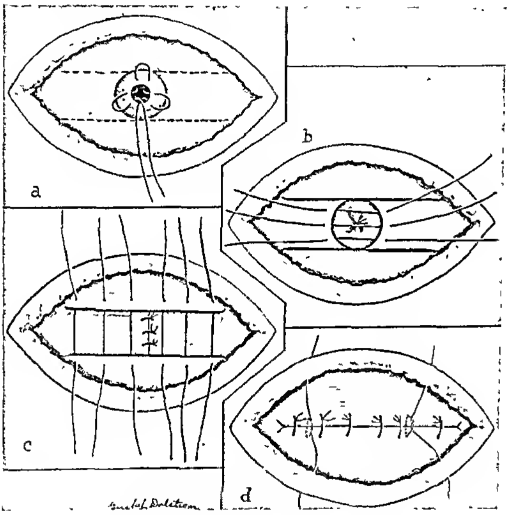


FIG 329. Umbilical herniotomy by the DuBose method.

a. Spontaneous hernia.

b. Acquired hernia.

1. Traumatic.
2. Incisional.

a. HERNIA LINEÆ ALBÆ

This type of hernia constitutes slightly more than one per cent of all hernia. It occurs in more than 90 per cent in males and in less than ten

per cent in females Two types of operation are employed for the radical cure of this type of hernia

1 The intraperitoneal operation, which is used in those cases in which either the abdominal viscera are the contents of the hernia (which is a very rare occurrence), or in which obscure clinical symptoms make it necessary to open the abdomen for exploratory purposes The closure of the abdomen is made either in the ordinary way, as in any laparotomy, or by a lateral overlapping method as described in the technic of the Sapiejko-Piccoli method of the surgical treatment of an umbilical hernia

2 The extraperitoneal operation (Moschcowitz technic)

Step 1 A small vertical incision is made over the hernial protrusion, cutting the skin and subcutaneous tissue A lump of fat is then exposed, which is the properitoneal fat (a continuation of the fat on the falciform ligament of the liver) This fat is teased away and its remnants are ligated to prevent a secondary hemorrhage A search is now made for one of the blood-vessels which penetrates the linea alba from within It usually lies to the left of the fat It is ligated The stump is now pushed downward and the edges of the transversalis fascia are sutured to each other by one or two interrupted sutures The skin is closed in the usual manner

b LATERAL VENTRAL HERNIA

To this group belong all the cases of protrusion of the abdominal viscera through the anterior abdominal wall with the exception of the inguinal, femoral, umbilical and linea alba herniæ If they are of the spontaneous variety, they usually protrude through the Spigelian line In cases of the post-incisional variety, they are observed at any place where the post-operative scar is present

1 Hernia lineæ semilunaris (Hernia of the Spigelian line)

This hernia is present at the lateral border of the rectus muscle, usually immediately below the place where the posterior sheath of the rectus muscle becomes deficient, that is, immediately below the semicircular line (the fold of Douglas) On the abdomen, it lies at the inner third of the line which connects the anterior superior iliac spine with the umbilicus The hernia may have one or more openings The sac may lie either subcutaneously, or still more frequently behind the aponeurosis of the lateral oblique muscles and in front of the transversalis fascia The hernial sac may lie above the inferior epigastric artery (which is comparatively rare) or below it (which is a frequent variety) The size of these herniæ is usually small The occurrence of the hernia of the Spigelian line is rare, but it gives a high percentage of strangulation The operative technic is the same as in a direct inguinal hernia

2 Post-incisional hernia

In the surgical treatment of this type of hernia it should be remembered

that if adhesions are present they are largely in the region of the fundus of the hernia. For this reason it is always advisable to make the elliptical incision so as to remove the skin close to the fundus together with the sac (if the latter is going to be removed). If the sac is not removed, then the skin close to the fundus is separated very carefully. The sac is incised at its neck [the latter can be found by pressing on the abdominal wall with a finger. A sharp edge is then felt which is the place where the neck is situated. The reason for incising the neck of the hernial sac is that there the adhesions are less pronounced. The closer it is to the fundus the more dense and abundant are the adhesions], and the separation of the hernial contents in the direction toward the fundus is begun. After the abdominal contents are returned back into the abdomen, the excess of the sac is excised and its edges sutured to each other. [An alternative method is not to open the sac at all, but to infold it so that it reinforces the closure of the ring by the more superficially lying structures.] Then all the structures (with the exception of the skin) on one side of the opening are sutured to the lip of the other side in an overlapping manner, as in Andrews' imbrication method. The edges of the skin are then sutured to each other.

E. DIAPHRAGMATIC HERNIA

I. ANATOMY (FIG. 330)

The diaphragm is a broad flat structure which serves as a partition between the thoracic and abdominal cavities. Its central portion is tendinous (pars tendinea) and its lateral portion is muscular (pars muscularis). The muscular portion is subdivided into three parts—the lumbar, the costal, and the sternal.

a. Pars lumbalis.—This consists of three crura on each side—medial, intermediate and lateral.

The medial crus takes its origin from the anterior surface of the bodies of the first, second and third lumbar vertebræ on the right side and from the first and second lumbar vertebræ on the left side. In front of the body of the first lumbar vertebra the fibers of the medial crus of one side decussate with the fibers from the other side, forming the aortic opening (hiatus aorticus) for the passage of the aorta. The tendinous band which connects the two medial crura is known as the *middle arcuate ligament*. In its further course, the fibers of the medial crus encircle the esophagus forming an elliptical opening (hiatus esophageus) and still further they join the central portion (centrum tendineum).

The crus intermedium is situated laterally from the medial crus. The splanchnic nerves pass through the opening between the medium and intermedium crura. The lateral crus lies laterally from the previously mentioned crura. It takes its origin chiefly from the medial lumbo-costal arch (which is a fibrous band stretched across the superior end of the psoas

muscle and attached to the body of the first or second lumbar vertebra medially and the tip of the transverse process of the first lumbar vertebra laterally), and some of its fibers from the lateral lumbo costal arch (which is a fibrous band stretched over the upper end of the quadratus lumborum muscle and attached to the transverse process of the first lumbar vertebra

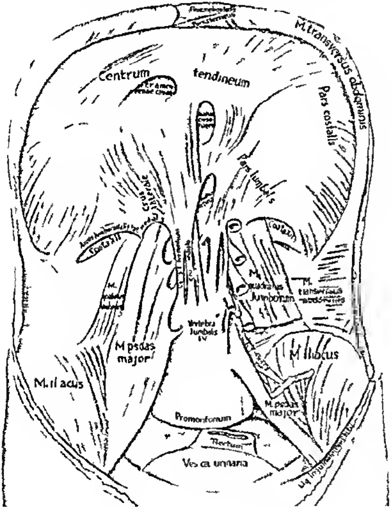


FIG 330 The diaphragm (after Rauber)

medially and to the twelfth rib laterally) The sympathetic trunk occasionally pierces the diaphragm between the intermediate and lateral crura

b Pars costalis —This takes its origin from the cartilages of the sixth to the twelfth ribs *There its muscular bundles interdigitate with the* muscular bundles of the transversus abdominis muscle After the digits of the costal portion fuse together they join the central part of the diaphragm

c. Pars sternalis.—This is the smallest subdivision of the diaphragmatic muscle. It arises from the dorsal surface of the ensiform process and from the posterior sheath of the rectus muscle of this vicinity and is directed to the central portion of the diaphragm.

The central part (centrum tendineum) has the shape of a three-leafed clover. On the anterior leaf (folium anterius) rests the heart with the pericardium. On each lateral leaf rest the medial portions of the base of each lung. At the posterior border of the anterior leaf lies the opening of the vena cava (foramen venæ cavæ) for the passage of this vein.

THE NERVES AND THE BLOOD-SUPPLY OF THE DIAPHRAGM

The diaphragm is innervated by the phrenic nerve on each side. This nerve is composed of fibers of the third, fourth and fifth cervical nerves, with occasional branches from the sixth cervical, and still rarer, from the second cervical nerve. In case a branch of the second cervical nerve participates in the formation of the phrenic nerve, it reaches this nerve through the descending branch of the hypoglossal nerve. In case the branch of the sixth cervical participates in the formation of the phrenic nerve it reaches this nerve through the subclavian nerve.

The blood-supply is derived from the branches of the internal mammary artery (aa. pericardiaco-phrenicæ and aa. musculo-phrenicæ) or from the branch of the abdominal aorta (a. phrenicæ inferior) and branches of the lower intercostal arteries.

OPENINGS IN THE DIAPHRAGM

The diaphragm has two large and several small openings through which different structures are transmitted from the chest into the abdominal cavity and *vice versa*. The third large opening (the aortic) actually lies behind the diaphragm.

a. Aortic opening (Hiatus aorticus). This opening lies between the crura underneath the middle arcuate ligament. Through it pass the aorta and the thoracic duct. The azygos vein, which is described by some anatomists as passing through this opening, is actually situated postero-laterally from the thoracic duct behind the right crus, so that strictly speaking it does not pass through this opening.

b. The vena caval opening (Foramen v. cavæ) lies in the right side of the central tendon. It transmits the vena cava inferior and occasionally the ramus phrenico-abdominalis of the right phrenic nerve.

c. The esophageal opening (Hiatus oesophageus) lies in the muscular portion of the diaphragm posterior to the central tendon. It transmits the esophagus and the two vagi nerves—the left vagus in the anterior part, and the right vagus in the posterior part of the opening.

d A slit between the crus mediale and crus intermedium through which pass the vena hemiazygos and the splanchnic nerves

e A slit between the crus intermedium and crus laterale through which passes the truncus sympathicus

f The sternocostal triangle (Larrey space) is situated between the sites of origin of the sternal and costal portions of the diaphragm Here the internal mammary artery is continued as the superior epigastric artery

g The costo-lumbar triangle (trigonum costo-lumbale) is situated between the quadratus lumborum muscle and the costal portion of the diaphragm

II CLASSIFICATION AND INCIDENCE

From the etiological standpoint, diaphragmatic herniæ are divided into congenital, acquired and traumatic types

Congenital hernia is present at birth A hernial sac may be present (true hernia) or absent (false hernia) This type constitutes about 29 per cent of all diaphragmatic herniæ

Acquired hernia is the type which develops after birth It usually develops in those areas which are congenitally weak They are usually of the true variety (*i e* they have a sac) They occur in about 36 per cent of all cases of diaphragmatic hernia

Traumatic hernia is the result either of a penetrating injury to the diaphragm or of rupture of the diaphragm due to sudden compression of the thoracic or abdominal walls It is of the false variety (no hernial sac is present) It occurs in about 35 per cent of all cases of diaphragmatic herniæ

About 80 per cent of non traumatic herniæ are on the left side and about 20 per cent on the right side About 95 per cent of the traumatic type are on the left side and 5 per cent on the right side

Herniæ through the esophageal opening comprise about 27 per cent of all non traumatic diaphragmatic herniæ on the left side and 9 per cent of all non traumatic herniæ on the right side Herniæ through the central portion of the diaphragm occur in about 20 per cent

In a few cases two diaphragmatic herniæ not connected with each other have been reported in the same patient

Contents of the Hernia

All of the abdominal viscera with the exception of the pelvic organs have been encountered in the hernial sac In the order of frequency they are The stomach, the colon, the omentum, the small bowel, the spleen, the liver, the pancreas, the kidney However, in the greatest majority of cases the contents are not some single organ but a combination of two or more abdominal viscera

III. OPERATIVE MANAGEMENT

The approach to the hernia may be from above by thoracotomy, or from below by celiotomy, or by a combined abdomino-thoracic approach. There is quite a divergence of opinion as to which approach is more advantageous. Each approach has its strong and weak points.

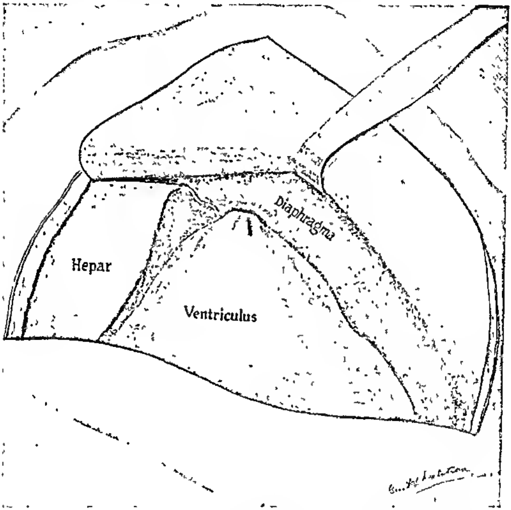


FIG 331. Diaphragmatic hernia. The stomach is incarcerated in the diaphragmatic opening

a. Thoracotomy gives a better access to the hernia opening. The contents of the sac can be more readily separated from each other and from the pericardium, pleura and lungs. It is easier to close the rent. The disadvantages of this method are: pneumothorax and greater difficulty in reducing the hernial contents into the abdominal cavity.

b. Celiotomy enables a good exploration of the viscera. The objections to this approach are that in many cases the hernial ring lies very deep, and

for this reason is inaccessible The difficulty and the dangers connected with the separation of adhesions which are present on the thoracic side of the hernial opening is greater when working on the abdominal side of the hernia

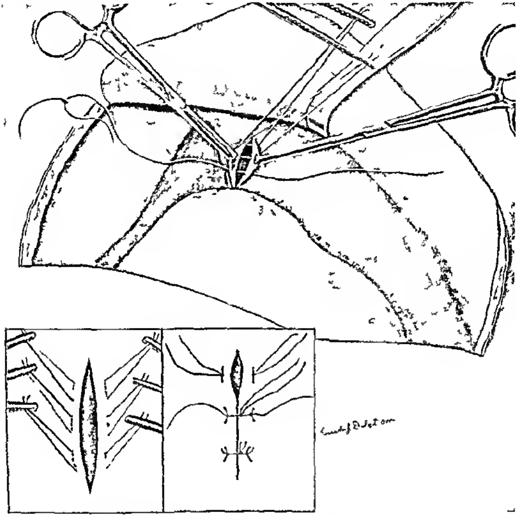


Fig 332 Diaphragmatic hernia Closure of the opening in the diaphragm *Insert*—The Sorest method of closure

c. Combined thoracolaparotomy.

This route of approach is the favorite one with French surgeons It has advantages over thoracotomy or celiotomy alone from the standpoint of better exposure However, it involves greater chances for infection

Thoracotomy Approach.

Different incisions are used by different surgeons Postempski used a U-shaped flap with the base upward, dividing two to four ribs in two

places. The method of Lannelongue, the method of Monod and Vanverts, and the method of Canniot have been already described in Chapter II.

Celiotomy Approach.

Different abdominal incisions are used for the approach to a diaphragmatic hernia: Midline, left pararectus, S-incision of Bevan, Fenger incision, left-side König-Perthes or Czerny-Perthes incision.

Combined Abdomino-Thoracic Approach.

A skin-incision, starting at the anterior axillary line in the seventh intercostal space, runs medially and slightly downward. When it reaches the midline it turns downward until it reaches the umbilicus. The pleural cavity is opened [differential pressure inhalation should be used]. Then the abdominal cavity is opened. The adhesions are separated, and the viscera reduced (Fig. 331). The margins of the opening are sutured to each other. Closure of the diaphragm can be made by a series of interrupted buttonhole sutures, or by mattress-sutures (Fig. 332).

In order to facilitate the closure of the opening in the diaphragm, Soresi takes a series of bites on each lip of the diaphragmatic opening parallel to its margin. He ties the ends of each thread to each other and then to the ends of the other side of the wound (Fig. 332, insert).

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CHAPTER XXV

GYNECOLOGICAL OPERATIONS

A. SURGICAL ANATOMY OF THE UTERUS AND ADNEXA (FIGS. 333 AND 334)

The uterus is a hollow muscular organ lying in the pelvic cavity between the bladder anteriorly and the rectum posteriorly. The normal uterus is 8 cm in length, 5 cm. in width (in the widest portion), and its maximum thickness is about 2½ cm. The uterus is subdivided into the fundus, corpus and cervix.

The fundus is that portion of the uterus which lies above the line connecting the points of entrance of each Fallopian tube into the uterus.

The corpus is the portion of the uterus lying below the line connecting the points of entrance of each tube into the uterus. It has two surfaces: the anterior or the vesical and the posterior or the intestinal.

The cervix uteri is cylindrical. It is about one inch long. Its lower end protrudes into the vagina, so that a portion of the cervix is supravaginal and the rest is intravaginal. At the point where the supravaginal portion enters the vagina it is attached to its margin. In the vaginal portion of the cervix lies its opening, the external orifice, through which the cervical canal and the uterine cavity are connected with the vagina. The opening of the external orifice of the cervix is formed by two lips, the anterior and the posterior. At the inner end of the cervix lies the opening which connects the cervix with the uterus. It is the internal orifice of the cervix and it lies in the supravaginal portion. The peritoneum covers the fundus and the corpus uteri until the bladder is reached. Then it leaves the uterus, being reflected on the bladder to form the uterovesical fold. From each side of the upper portion of the uterus extends a uterine tube (Fallopian tube, O.T.), which conveys the oöcytes to the cavity of the uterus. Each tube is about four inches long. It opens into the pelvic cavity at one *end (abdominal ostium) near the ovary, and into the uterine cavity at the* other end (uterine ostium).

The abdominal end of the tube is also called the fimbriated end because of numerous irregular small projections which surround this end and which are called fimbriæ. Each tube is subdivided into the infundibulum (the lateral portion of which is the fimbriated end), the ampulla (which forms the largest portion of the tube), the isthmus (which joins the lateral angle of the uterus), and the uterine portion (pars uterina), which traverses the thickness of the uterine wall and enters the cavity of the uterus. The abdominal ostium is 2 mm. wide and the uterine ostium is only 1 mm. Therefore, probing of these openings is not an easy matter.

The ovaries, two in number, are almond-shaped and they are about one and one-half inches long, and about half an inch in thickness. They lie against the lateral wall of the pelvis. They are connected by peritoneal folds with the pelvic wall and with the broad ligament of the uterus. Each ovary has two extremities—the superior (or the tubal) and the inferori

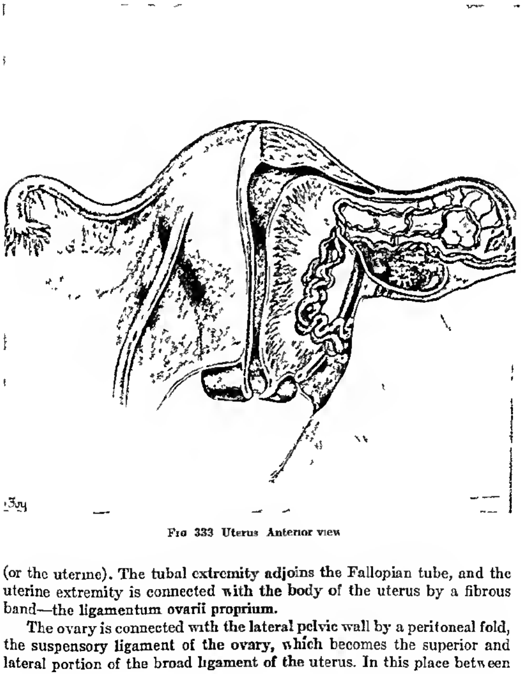

Fig 333 Uterus Anterior view

(or the uterine). The tubal extremity adjoins the Fallopian tube, and the uterine extremity is connected with the body of the uterus by a fibrous band—the ligamentum ovarii proprium.

The ovary is connected with the lateral pelvic wall by a peritoneal fold, the suspensory ligament of the ovary, which becomes the superior and lateral portion of the broad ligament of the uterus. In this place between

the leaflets of the broad ligament are situated the ovarian vessels and the sympathetic plexus which run from the lateral pelvic wall until they reach the hilum of the ovary. The ovary is connected with the posterior aspect of the broad ligament by a very short peritoneal fold—the meso-ovary so that the ovary lies behind the two leaflets of the broad ligament.

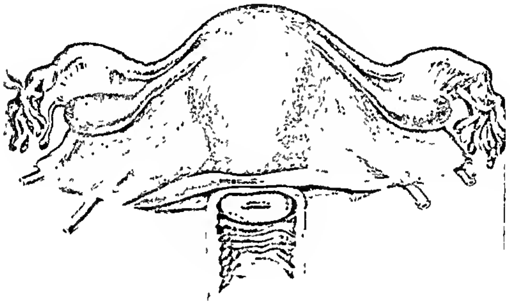

FIG. 334. Uterus. Posterior view (after Rauber).

The broad ligament of the uterus is a paired peritoneal fold which extends between the lateral border of the uterus and the pelvic wall on each side. It consists of two leaflets—the anterior and the posterior. It embraces in its upper border the tube, which it invests on all sides. This portion is called the mesosalpinx. The portion of the broad ligament below the mesosalpinx is termed the mesometrium. The ureter and the uterine vessels traverse the lower portion of the mesometrium in the region where

the mesometrium joins the pelvic floor Between the layers of the mesometrium, close to the cervix uteri on each side, is a mass of fibrous and muscular tissue which is termed the lateral cervical ligament

The round ligament of the uterus is a paired cord-like structure each of which is attached to the body of the uterus slightly below the opening of the tube into the uterus It extends in front of the anterior leaflet of the broad ligament in a forward and lateral direction, crosses the brim of the pelvis and enters the inguinal canal It traverses the latter through its entire length, leaves it through the subcutaneous inguinal ring, and ends in the skin and the subcutaneous tissue of the labium majus on each side

B OPERATIONS FOR RETRODISPLACEMENT OF THE UTERUS

Numerous operations have been suggested for the correction of uterine retrodisplacement They differ from each other either by the method of approach (incision of the inguinal canal, celiotomy through a midline incision, vaginal approach), by the structures which serve for fixation (the body of the uterus, the round ligament, the broad ligament), and by the structures to which they are attached (anterior abdominal wall hammock-like position of the round ligament)

F F Simpson groups all the different methods of fixation into the following

1 Inguinal shortening of the round ligaments
2 Vaginal shortening of the round ligaments
3 Intra-abdominal shortening of the round ligaments
4 Attachment of the round ligaments posterior to the uterus
5 Attaching the uterus to the anterior abdominal wall firmly, loosely or indirectly
6 Transperitoneal shortening of the round ligaments
7 Retroperitoneal shortening of the round ligaments
8 Shortening of the sacro uterine ligaments through the abdomen or vagina
9 Transverse attachment of the base of the broad ligaments in front of the cervix
10 Intraperitoneal shortening of the round and broad ligaments

Of the numerous methods suggested only a few are employed today

1 GILLIAM OPERATION

This operation consists in grasping the round ligament on each side, bringing it through a perforation made in the anterior abdominal wall and suturing the protruded portion of the ligament to the anterior sheath of the rectus muscle

Technic.

Step 1. A temporary ligature is placed around the round ligament of each side at a distance of about one to one and one-half inches from its attachment to the uterus. The thread is clamped by an artery-forceps (Fig. 335).

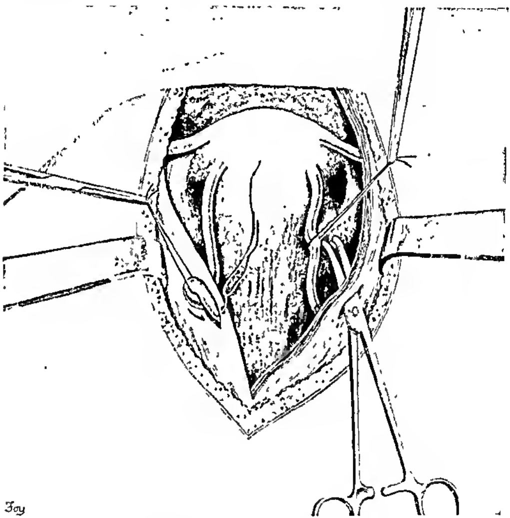

Fig. 335. Fixation of the uterus. Gilliam method.

Step 2. A small incision about one inch long is made through the anterior sheath of the rectus muscle, the rectus muscle itself, the transversalis fascia and peritoneum at a distance of one and one-half inches above the pubic bone and one inch lateral from the midline incision. An ordinary forceps is inserted into this opening from without inward, which grasps the thread and brings it and the round ligament outside. The same is done on the other side.

Step 3 The loop of each round ligament is sutured to the aponeurosis of the rectus muscle of the corresponding side

Step 4 The abdomen is closed in layers

In this operation the uterus is held forward by strong fibrous round ligaments This hold is stronger than the normal hold in the healthy

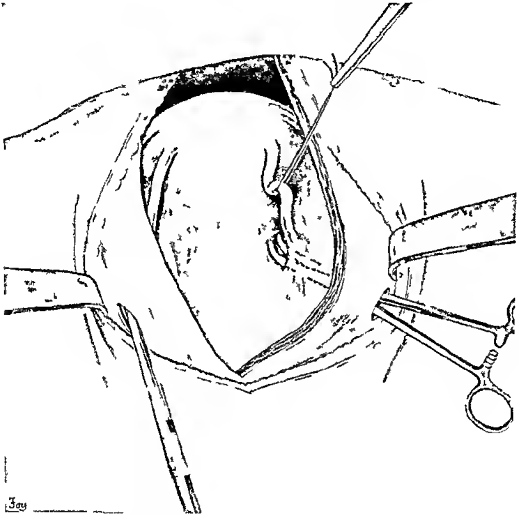

Fig 336 Fixation of the uterus Simpson Montgomery method

female, which is a lateral one The only objection to this method is that the opening between the internal inguinal ring and the round ligament may become the seat into which a loop of bowel may slip and produce internal strangulation Nevertheless, this is an excellent method and is used more frequently than any other method

2 SIMPSON MONTGOMERY METHOD (FIG 336)

This method, which may be characterized as a subperitoneal trans-

plantation of the round ligament with a forward pull, was described by Simpson, of Pittsburgh, in 1902, and later modified by Montgomery, of Philadelphia, in 1904, so that the description below is actually Montgomery's modification of the Simpson method.

The technic of this modification is as follows:

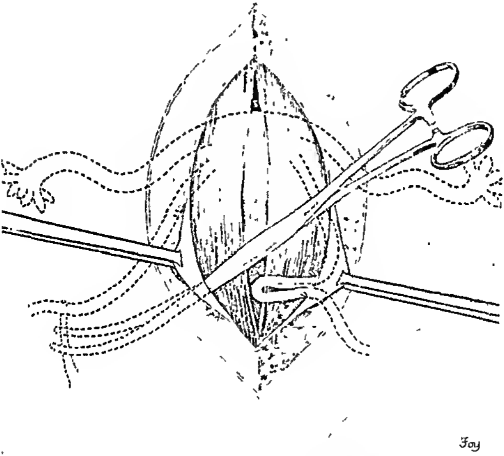

Fig. 337. Fixation of the uterus. Barrett method.

Step 1. A temporary ligature is passed around the round ligament at a distance of one and a half inches from the uterus.

Step 2. The skin of the abdominal wound is retracted until the outer edge of the anterior sheath of the rectus muscle is reached. The anterior sheath is incised for a length of half an inch at the outer edge of the rectus muscle. A clamp then penetrates a part of the thickness of the anterior abdominal wall down to (but not through) the peritoneum. Then it passes

between the leaflets of the broad ligament until the place is reached where the round ligament was ligated At this point the forceps penetrates the leaflet of the broad ligament, grasps the thread and carries it with the round ligament along the track made by the forceps until the loop of the round ligament appears external to the anterior sheath of the rectus muscle Here it is fastened to the slit in the anterior sheath The same is done on the other side

3 BARRETT METHOD (FIG 337)

This technic has several points in common with the Simpson-Montgomery method The characteristic feature of this method is that the round ligament is transplanted intramurally with a lateral pull

Step 1 A temporary ligature is placed around the round ligament at a distance of two and half inches from the uterus

Step 2 A curved artery forceps enters the abdominal wall at the median incision behind the anterior sheath of the rectus muscle and passes along the wall until the internal inguinal ring is reached Then the forceps is thrust through the peritoneum, grasps the ligature and carries it together with the round ligament back until it appears in the midline beneath the anterior sheath of the rectus muscle The same is done on the other side Each loop of the round ligament is sutured to the under surface of the anterior sheath of its respective side at a distance of about one inch from the median line

In this method the forward pull is replaced by a lateral pull It does not offer such a strong hold as a forward pull, but strong enough to keep the uterus in its new position At the same time there are no rings formed (as in the Gilliam method) in which a loop of bowel may become strangulated This is an excellent method of fixation of the uterus

4 WEBSTER BALDY OPERATION (FIG 338)

This operation was described by Webster, of Chicago, in 1901, and by Baldy, of Philadelphia, in 1902 In France it is known as the ' Dartigue operation " However, the latter practised this operation only since 1905, and his first report of it appeared in April, 1906 (Presse Médicale, April 7, 1906) Therefore, neither in time of operation nor in time of first publication can the priority be attributed to him

Technic.

Step 1 A curved artery-forceps penetrates the broad ligament from behind forward immediately below the utero ovarian ligament It then grasps the round ligament and draws it through the rent in the broad ligament The same is done on the other side The ligaments are grasped one to two inches from the uterus

Step 2. The round ligament of each side is sutured to the posterior wall of the uterus and to each other in the midlioe. The round ligament should also be sutured to the broad ligament at the point where it passes through the opening in the ligament.

In this method, the uterus rests as on a hammock and no free bands

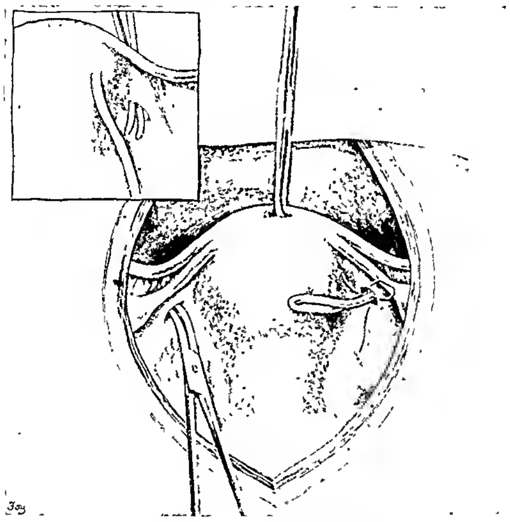

FIG 338. Fixation of the uterus. Baldy-Webster method.

are left in the abdominal cavity, so that there is no danger of intestinal obstruction. However, the hold of the uterus is not very strong.

In the following group of operations known as ventro-fixation, the uterus is attached to the anterior abdominal wall either by including in the bite only the muscle of the fundus uteri (Leopold technic), the muscle of the anterior surface of the fuodus with the round ligament (Olshausen

technic), or the muscle of the posterior surface of the fundus with the utero-ovarian ligament (Kelly technic)

5 LEOPOLD TECHNIC (FIG 339 a)

Step 1 A bite is taken through one lip of the anterior abdominal wall (except the skin), at a distance of two inches above the pubic bone

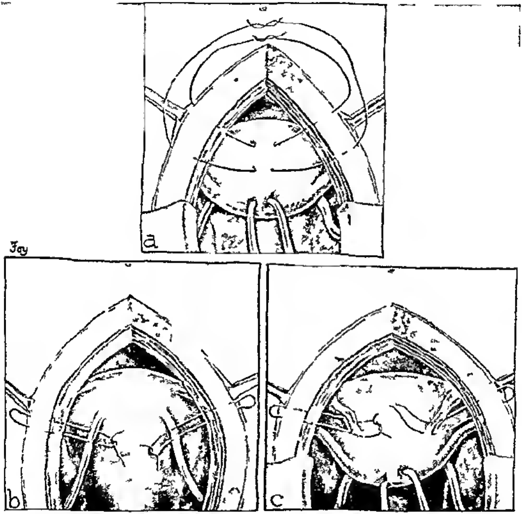

FIG 339 Fixation of the uterus a Leopold method b Olshausen method c Kelly method

It then passes through the muscle of the posterior wall of the fundus uteri, and then through the entire thickness of the other abdominal lip (except the skin) The same procedure is repeated at a distance of one inch below the place in which the first suture was inserted The ends of the sutures are tied and cut short

6. OLSHAUSEN TECHNIC (FIG. 339, b)

Step 1. A bite is taken through the anterior surface of the wall of the fundus so as to include the round ligament, then through the entire thickness of one of the lips of the anterior abdominal wall (except the skin), then back through the anterior abdominal wall of the same side, and the ends are tied within the abdominal cavity. The same is done on the other side.

7. KELLY TECHNIC (FIG. 339, c)

Step 1. This is done in a manner analogous to the Olshausen operation with this difference, that the portion of the posterior wall of the uterus with the utero-ovarian ligament is included instead of the anterior wall with the round ligament.

All the methods of ventro-fixation are contra-indicated when future pregnancy is possible.

C. SALPINGECTOMY, OÖPHORECTOMY, SALPINGO-OÖPHORECTOMY.

I. SALPINGECTOMY

Definition.

This term consists of two Greek words: σάλπιγξ, the tube and ἐκτομή, excision. It signifies: the excision of a tube.

Indications.

a. Pyosalpinx.
b. Hematosalpinx.
c. Tuberculosis of the tubes.
d. Malignancy (carcinoma of the tubes).
e. Ectopic pregnancy.

Technic.

Step 1. The abdomen is opened by a longitudinal or a transverse (Pfannenstiel) incision. The patient is placed in the Trendelenburg position.

Step 2. The edge of the mesosalpinx is grasped between the fimbriated end of the tube and the ovary. Thus, the tube is placed on a stretch (Fig. 340, insert).

Step 3. An artery-forceps clamps the mesosalpinx along its entire length, which is now cut between the clamp and the tube (Fig. 340).

Step 4. An incision is made around the corner of the fundus of the uterus just beyond the tubo-uterine junction.

Step 5. The mesosalpinx and the open end of the uterus are closed by a continuous suture starting at the lateral edge of the mesosalpinx. Thus, the uterine portion is sutured last (Fig. 341).

The suturing line of the angle of the uterus is reinforced by another layer of sutures

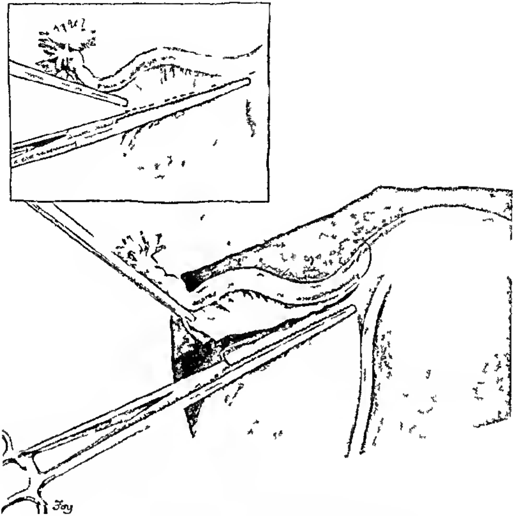

FIG 340 Salpingectomy *Insert*—The mesosalpinx is clamped *Main picture*—The mesosalpinx is cut The tube is ready to be cut at the utero tubal junction

II OÖPHORECTOMY (FIG 342)

Definition

This term consists of 3 Greek words ὠόν, egg, φέρειν, to bear, and ἐκτομή, excision It signifies the excision of an ovary

This operation was first performed by Ephraim McDowell, in 1809

Indications

a Ovarian cyst
b Infection of the ovary
c Chronic inflammation of the ovary
d Neoplasm of the ovary

Technic.

Step 1. The abdomen is opened by a longitudinal or a transverse incision. The patient is placed in the Trendelenburg position.

Step 2. The ovary is lifted. One artery-forceps clamps the ligamentum ovarii proprium with the adjoining portion of the mesovarium (on the

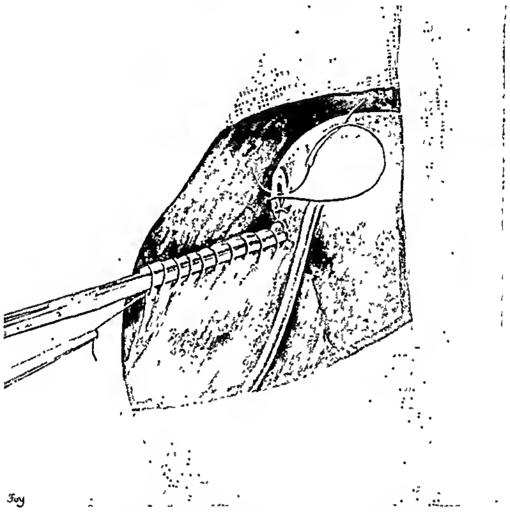

FIG 341. Salpingectomy. The mesosalpinx is sutured over the clamp; the cornu uteri is in process of closure.

uterine side), and another clamps the fimbria ovarica with the adjoining portion of the mesovarium (on the lateral side) (Fig. 342). The mesovarium is cut between the clamps and ovary, and is sutured over the clamps by a running suture (Fig. 342).

However, as far as possible an attempt should be made to preserve

at least a part of the ovary, and whenever possible to do a resection of the ovary instead of an oophorectomy

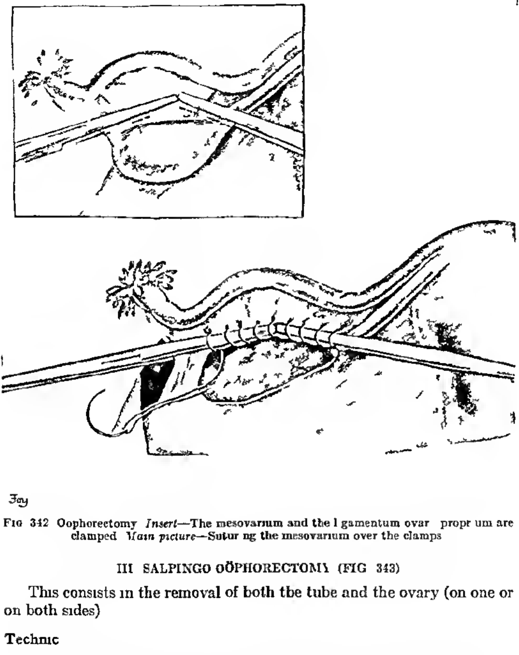

Fig 342 Oophorectomy *Insert*—The mesovarium and the ligamentum ovarii proprium are clamped *Main picture*—Suturing the mesovarium over the clamps

III SALPINGO OÖPHORECTOMY (FIG 343)

This consists in the removal of both the tube and the ovary (on one or on both sides)

Technic

Step 1 The abdomen is opened by a midline or transverse incision The patient is placed in the Trendelenburg position

Step 2 The fundus uteri is located as a starting point and from it begins the search for the tube and the ovary, which when found are

separated from their adhesions. The infundibulopelvic ligament is clamped by two arterial forceps at a point midway between the fimbriated end of the tube and the brim of the pelvis, and is cut between the forceps. The utero-ovarian ligament (ligamentum ovarii proprium) is clamped by two

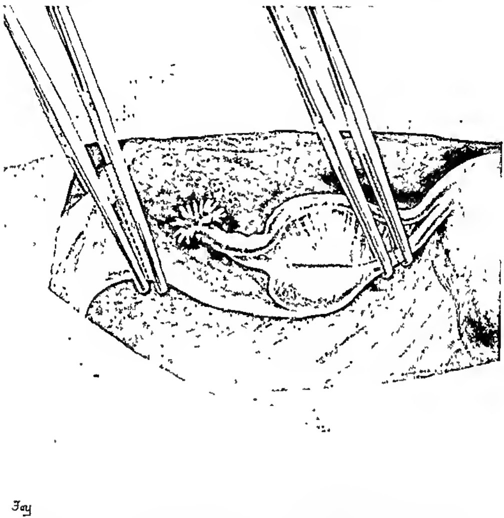

FIG. 343. Salpingo-Oöphorectomy. The infundibulopelvic ligament and the ligament ovarii proprium are clamped each by a pair of artery-forceps.

artery-forceps and cut between them. The tube is then removed in the same manner as described under "salpingectomy" (Fig. 340). The infundibulopelvic ligament is ligated by a transfixing suture. The cornu uteri is sutured in two layers. The ligamentum ovarii proprium is ligated. The two leaflets of the broad ligament are united to each other by a continuous suture.

D OPERATIONS DEALING WITH STERILITY

These include

a Operations for the correction of sterility

b Operations producing sterility

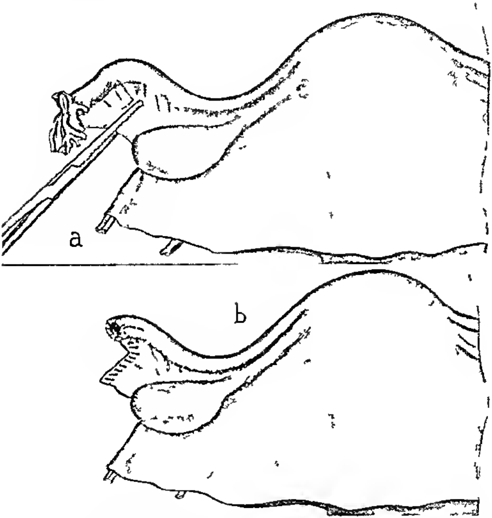

FIG 344 Correction of sterility a The fimbriated end of the tube is ready to be removed b The fimbriated end is removed the lumen of the tube is enlarged

a OPERATIONS FOR THE CORRECTION OF STERILITY

Here we discuss only some of those operative procedures which are employed in the cases in which sterility is due to occlusion of the Fallopian tubes Occlusion of the fimbriated ends gives the best prognosis from the standpoint of overcoming the sterility Occlusion of the isthmic portions gives a very bad prognosis In case both tubes are occluded in the isthmus and in which neither can be opened by inflation of air, transplantation of

the undamaged portion of the tubes into the fundus uteri may be resorted to with some hope of success.

In case of occlusion of the fimbriated end of the tube the technic is as follows (Fig. 344).

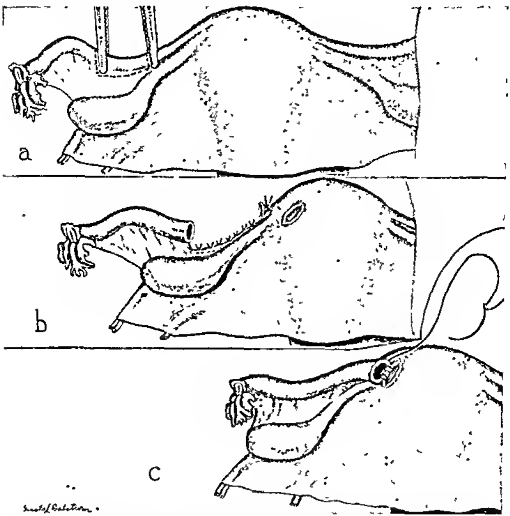

FIG. 345. Correction of sterility. a. The isthmic portion of the tube is ready to be excised; b. The isthmic portion of the tube is removed. c. Implantation of the fimbriated end of the tube into the uterus.

Step 1. The mesosalpinx is grasped by an artery-forceps close to the fimbriated end. The tube is freed from the mesosalpinx along the entire length of its diseased portion. All bleeders are checked. The tube is amputated at the portion where the wall is healthy.

Step 2. A longitudinal incision is made in the tube on its free border (that is on the border opposite to the attachment of the mesosalpinx) for

a distance of half an inch, and the angle is rounded. Thus, the lumen of the opening becomes increased. The edges of the wound are whipped over by fine catgut.

In case of occlusion of the isthmus of the tube the technic is as follows:

Step 1. The mesosalpinx is grasped by an artery-forceps close to the fimbriated end. The tube is placed on a stretch and is then clamped by *two artery-forceps just lateral to the diseased isthmic portion.* It is cut between the clamps. The isthmic portion is ligated (or it may be removed entirely) (Fig. 345, a).

Step 2. The lumen of the open end of the tube is enlarged by making a longitudinal incision on its free border for a distance of half an inch. Then the angles of the flaps thus formed are rounded (Fig. 345, b).

Step 3. A seromuscular incision for the length of one inch is made through the fundus of the uterus. The exposed mucosa is opened for the length of half an inch in its center. The edges of the tube and of the opened mucosa of the uterus are sutured to each other by several interrupted sutures. The lips of the seromuscular layer are now sutured to each other (Fig. 345, c).

b. OPERATIONS PRODUCING STERILITY (FIG. 346)

No surgeon will remove the ovaries in order to sterilize a patient. Different procedures to accomplish sterilization have been suggested, such as a mere ligation of the tube by one ligature, ligation of each tube by two ligatures and cutting the tubes between them, resection of the tubes with or without burying the ligated stumps in the leaflets of the broad ligament, and many others. The reason for this large number of methods is that none of them gives a complete assurance that pregnancy will be eliminated. Of all the methods suggested, the Neumann method seems to be the most reliable. It consists in the removal of a portion of the tube close to the fundus, and also of the interstial portion of the tube, and then in closure of the opened end of the uterine cornu and the suturing of the closed peripheral end of the tube to the closed cornu uteri. Crossen covers the closed cornu uteri by the round ligament.

Technic.

Step 1. The tube is clamped by two forceps at a distance of one-half an inch from the cornu uteri and is cut between the clamps. The distal end is ligated and buried in the leaflets of the broad ligament (Fig. 346, a and c).

Step 2. The proximal portion of the tube is excised together with the uterine cornu, which is then closed by several interrupted sutures (Fig. 346, a, b).

Step 3. The round ligament is fastened to the sutured cornu of the uterus (Fig. 346, d).

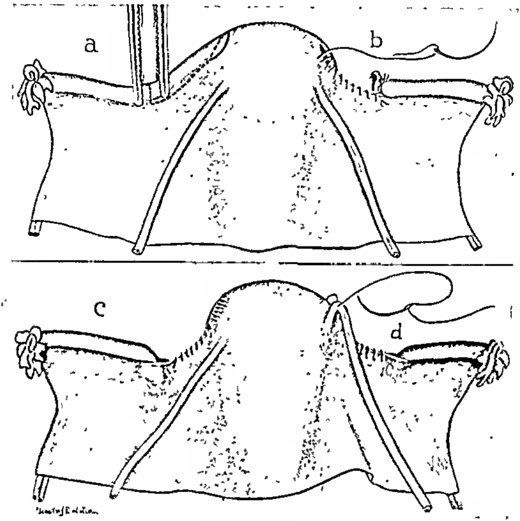

FIG 346. Producing sterility Neumann method.

E. HYSTERECTOMY

This term consists of two Greek words: ὑστέρα, uterus, and ἐκτομή, to excise. It signifies the excision of the uterus. According to the route of approach this operation is subdivided into two groups

a. Abdominal.

b. Vaginal.

Abdominal hysterectomy is again subdivided into two groups:

a. **Supravaginal hysterectomy,** in which the fundus and the body are removed but the cervix uteri is left behind.

b. **Complete (total) hysterectomy** in which the cervix uteri is also removed.

The technic of hysterectomy varies according to whether the adnexa are removed or left, and also whether a preliminary ligation of the blood-vessels is made or the "clamp method" is employed for preventing hemorrhage

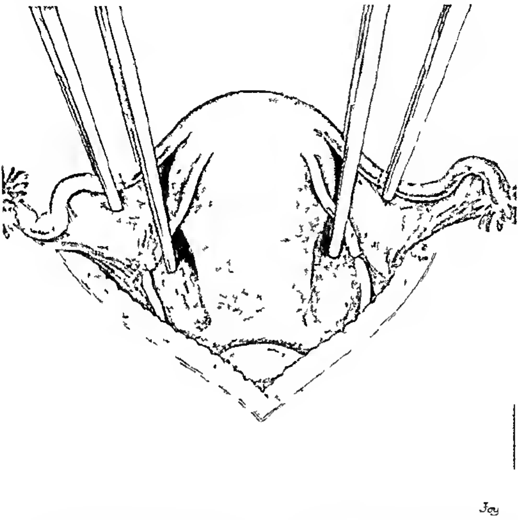

FIG 347 Supravaginal hysterectomy The tube, broad ligament and round ligament are caught on each side by an artery forceps the tube on each side is clamped by an artery forceps lateral to the previously placed clamps

a SUPRAVAGINAL HYSTERECTOMY

Indications

a Fibromyoma uteri, particularly when the tumors are large or numerous

b. Chronic metritis

c. General fibrosis of the uterus

d. Myopathic hemorrhages which do not yield to any other method of treatment.

Technic.

Step 1. *After the abdomen is opened by a midline or a transverse incision the patient is placed in the Trendelenburg position.* The Fallopian

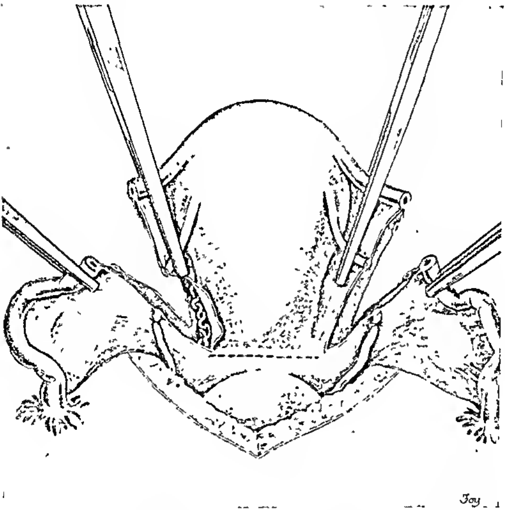

Fig. 348. Supravaginal hysterectomy. The tubes and adnexa are cut between the clamps. The utero-vesical fold is ready to be cut.

tube, the round ligament, the ligamentum ovarii proprium, and part of the broad ligament are grasped at each side by an artery-forceps which extends along the side of the uterus down to its middle portion (Fig. 347). [This maneuvre eliminates the necessity of employing a uterine grasping-forceps, which occasionally perforates the wall of the uterus.] The body

of the uterus is now brought forward and laparotomy pads are placed behind the uterus to cover the loops of small bowel and prevent them from slipping into the operative field [The thoroughness of covering the bowel is very much facilitated by bringing the uterus forward before the pads are placed in the pelvis behind it]

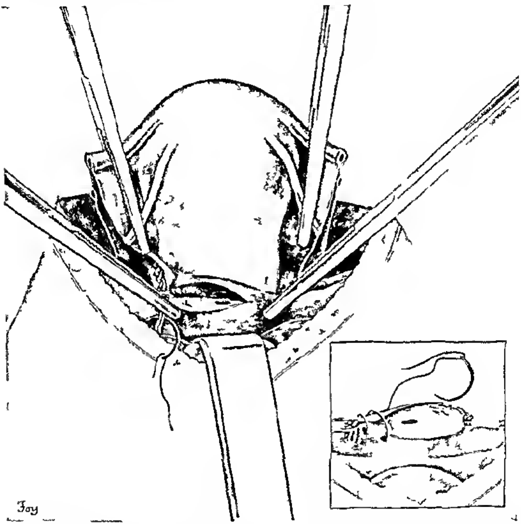

Fig 319 Supravaginal hysterectomy *Main picture*—The uterine arteries are clamped Beginning to cut through the cervix uteri *Insert*—The uterine vessels are ligated Closure of the cervix uteri is begun

Step 2 An artery forceps clamps each tube at a distance of half an inch from the forceps that clamped the tubo uterine junction in Step 1 The tube is cut between the clamps on each side, and the stump is ligated by a transfixing suture The round ligament is ligated lateral to the body of the uterus and is cut on each side between the ligatures and the clamp placed in Step 1 (Fig 347)

Step 3. The utero-vesical fold is lifted by two tissue-forceps and cut between them. The opening is enlarged to the right and to the left (Fig. 348). A finger is introduced into the opening and the bladder is pulled upward, separating it from the upper portion of the cervix uteri.

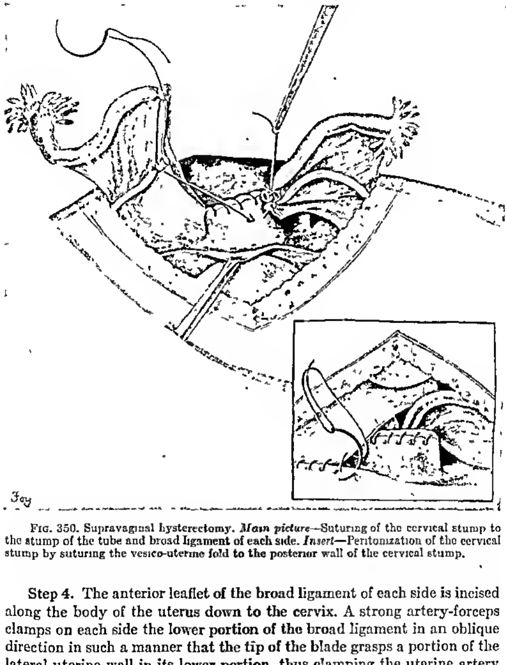

FIG. 350. Supravaginal hysterectomy. *Main picture*—Suturing of the cervical stump to the stump of the tube and broad ligament of each side. *Insert*—Peritonization of the cervical stump by suturing the vesico-uterine fold to the posterior wall of the cervical stump.

Step 4. The anterior leaflet of the broad ligament of each side is incised along the body of the uterus down to the cervix. A strong artery-forceps clamps on each side the lower portion of the broad ligament in an oblique direction in such a manner that the tip of the blade grasps a portion of the lateral uterine wall in its lower portion, thus clamping the uterine artery on each side (Fig. 349).

Step 5. The uterus is cut transversely at a level of half an inch above the point where the artery-forceps clamps the uterine vessels The cervical canal is disinfected by tincture of iodine and alcohol (Fig 349)

Step 6 The uterine vessels are ligated by a transfixion suture of chromic catgut No 2 on each side (Fig 349)

Step 7. The opening leading into the cervical canal is closed by a continuous row of sutures (No 2 chromic catgut) (Fig 349, insert)

Step 8 The stump of each tube is sutured to the cervical stump (Fig 350)

Step 9 The utero vesical fold which was dissected in Step 3 is brought over the sutured stump of the cervix and sutured to its posterior (intestinal) surface Thus, the stump is peritonized (Fig 350 insert)

The omentum is brought over the cervical stump If, however, the omentum is not long enough, then it is advisable to place the sigmoid over the stump Otherwise a loop of small bowel may become adherent to the stump and produce an intestinal obstruction

b TOTAL HYSTERECTOMY

In this operation not only the body of the uterus but also the cervix is removed

Indications

a Malignancy of the uterus

b Myoma of the uterus involving also the cervix

c Any pathology of the uterus requiring supravaginal hysterectomy together with the presence of severe lacerations of the cervix

Technic

The vagina is well disinfected by a 5 per cent solution of tincture of iodine, followed by alcohol Then

Steps 1 to 3 are the same as in supravaginal hysterectomy, with this difference that the tubes as a rule are removed and that separation of the bladder from the uterus and cervix is carried farther than in the case of supravaginal hysterectomy The bladder is separated from the wall of the vagina as low as possible Then, with the aid of the thumb placed on the posterior wall of the vagina and of the index finger placed on the anterior vaginal wall, the cervix uteri is palpated so that the surgeon is able to decide whether the separation of the bladder from the cervix in a downward and lateral direction is sufficient (Fig 351, insert)

Step 4 Two strong toothed forceps clamp the broad ligaments and the parametrium lateral to the cervix on each side of the uterus along its entire length down to the wall of the vagina The clamps are placed obliquely so that the blades lie closer to the midline than the handles

The broad ligaments and the parametrial tissues are cut between each pair of clamps. [*Extreme care should be taken not to catch the ureter in the clamp.*] (*Fig. 351*).

Step 5. A longitudinal incision is made on the anterior wall of the vagina for the length of one inch (Fig. 352). Each lip of the incised vaginal

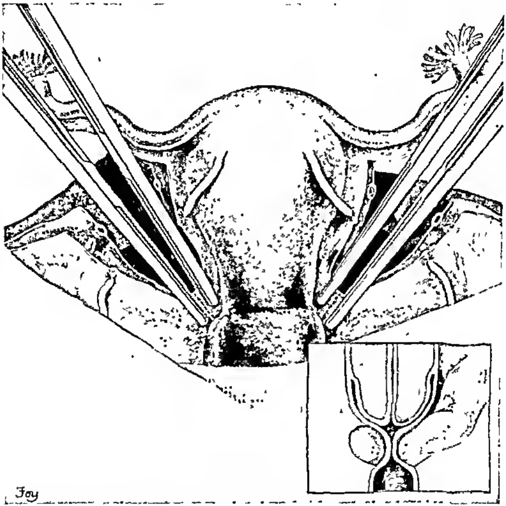

FIG. 351. Total hysterectomy. *Main picture*—The infundibulopelvic ligament, the round ligament and the broad ligament on each side are cut; two clamps are clamping the parametrium on each side of the cervix. *Insert*—Palpation of the cervix uteri to be sure that the bladder is separated from the cervix for its entire length.

wall is then grasped by a forceps. The opening into the vagina is disinfected from above by a 5 per cent solution of iodine. The vagina is now cut circularly very close to the cervix [*this proximity to the cervix greatly diminishes the possibility of cutting the ureters.*] (Fig. 352, upper insert). It is done first on the anterior vaginal wall. Then, after the cervix is pulled

out of the vagina and turned laterally, the posterior vaginal wall becomes well exposed and is cut circularly very close to its attachment to the cervix

Step 6 The vagina is closed with or without drainage of the pelvic cavity (Fig 352, lower left insert)

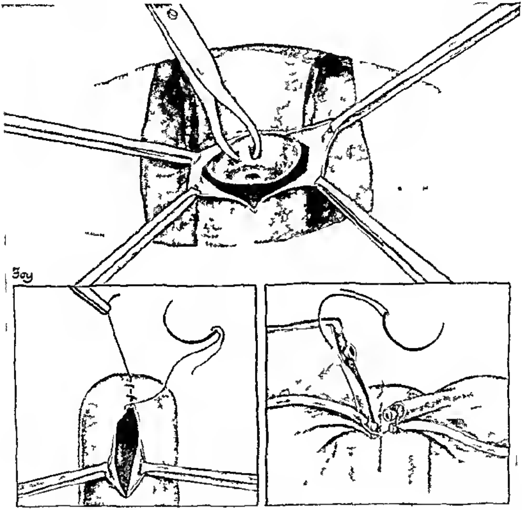

Fig 352 Total hysterectomy *Upper insert*—The wall of the vagina is opened and is cut away from the cervix *Lower left insert*—Closure of the vagina after removal of the uterus *Lower right insert*—The round ligament broad ligament and infundibulopelvic ligament of each side are attached to the vagina

Step 7 The stumps of the broad ligament are sutured to the vagina Thus, prolapse of the vagina is prevented (Fig 352, lower right insert) *The utero-vesical fold covers now the vaginal stump and is sutured to the* posterior wall of the vagina Thus, the stump is peritonized

Step 8 The abdomen is closed

F. DEFUNDATION

This operation consists in the removal of the fundus uteri (together with the tubes). The first who suggested and performed this operation was Dührssen, for the treatment of chronic metritis. However, the operation was not used until Oscar Beuttner suggested it again in 1908. He increased the operative indications and described its technic, and for this reason he is considered as the originator of the operation. W. Blair Bell, in 1914, also described the operation as a new method. The operation is known as the "Beuttner Operation" and as the "Bell-Beuttner operation." However, the priority belongs to Dührssen.

Indications.

1. In all cases in which salpingectomy or salpingo-oöphorectomy is indicated.
2. Chronic metritis.

The operation is usually done on comparatively young women in whom it is desirable to preserve menstruation.

BEUTTNER OPERATION

Technic.

Step 1. The abdomen is opened by a longitudinal or a transverse (Pfannenstiel) incision. The patient is placed in the Trendelenburg position. The bowels are displaced upward and covered by moist laparotomy pads.

Step 2. The fundus of the uterus is grasped by a strong uterine forceps. A wedge-incision is made on the fundus cutting first the anterior and then the posterior surface. The size of the wedge depends on whether one or both ovaries are removed, or whether both ovaries are preserved. The fundus is now cut in a sagittal plane, each half of which is grasped by a forceps and cut away, starting at the median line and continuing in a lateral direction. The bleeding point of the uterine artery is caught and ligated. The diseased adnexæ are removed by continued cutting in a lateral direction over a previously placed clamp on the mesosalpinx (technic of Faure) until the infundibulopelvic ligament is reached. This ligament is clamped in case the ovary is removed. Otherwise it is not clamped.

Step 3. The infundibulopelvic ligament is sutured over the clamp by a continuous suture, which when continued closes the broad ligaments. A continuous catgut suture closes the opening in the uterus.

BELL MODIFICATION OF THE BEUTTNER OPERATION

Step 1. The same as Step 1 in the previous operation.

Step 2. A wedge-shaped incision is made through the fundus starting about half an inch below the point of the tubo-uterine junction. Thus,

the attachment of each round ligament to the body of the uterus is severed The incision is made in a crater form that is in such a manner that each deeper lying structure is cut farther away from the fundus than the more superficial The branch of the uterine artery lying at the lateral side of the

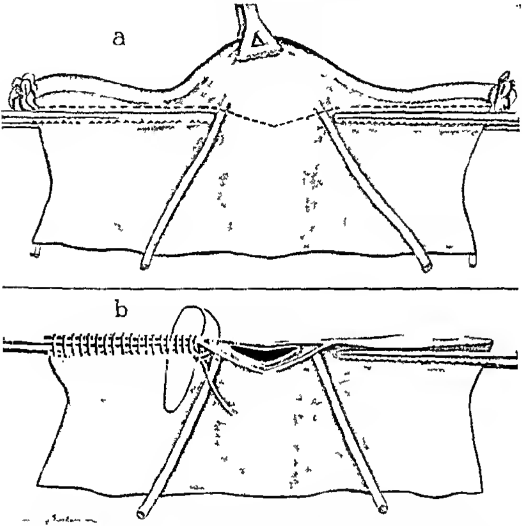

Fig 353 Defundation a Artery forceps clamps each mesosalpinx Another forceps grasps the fundus uteri Dotted lines show the line of intended incision b The tubes and fundus are removed Suturing of the mesosalpinx and the corpus uteri is begun

body of the uterus is clamped and ligated as soon as the fundus uteri is cut at this point (Fig 353 a)

Step 3 The tube is separated in a direction beginning medially and extending laterally over a forceps which clamps the mesosalpinx [N B The ovaries are not removed unless this is imperative on account of the pathology present] (Fig 353, a)

Step 4. The leaflets of the broad ligament are sutured over the clamp, *which is then removed. This suture is continued on the uterus, closing* its open wound, and then on the hroad ligament of the other side (Fig. 353, b).

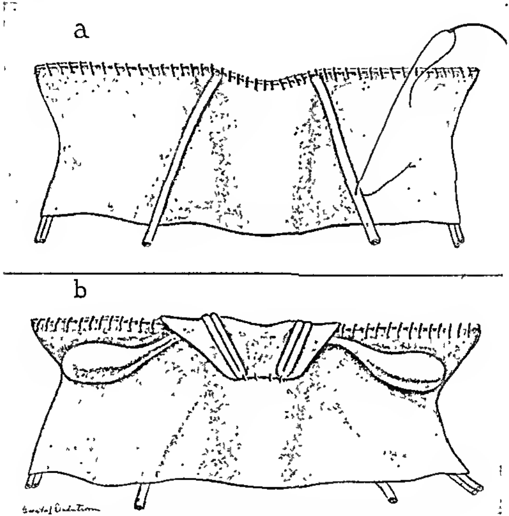

FIG 354. Defundation. a The mesosalpinx and the corpus uteri are sutured. b. The round and broad ligaments of each side are covering the raw areas.

Step 5. The round ligament on each side is brought over the raw surface of the closed uterus and sutured to its posterior wall (Fig. 354, a, b). This accomplishes two things. It peritonizes the raw surface of the uterus, and by properly adjusting the round ligaments it lifts the remaining portion of the uterus, thus preventing the possibility of its retroversion and prolapse.

The advantage of defundation over salpingectomy is that it more thoroughly removes the pathology, since it is a well known fact that salpingitis is quite frequently associated with pathological changes in the fundal endometrium Its advantage over supravaginal hysterectomy is that menstruation is preserved and there is no interference with the bladder

G CESAREAN SECTION

Definition

This is the delivery of a child through an incision in the abdominal and uterine walls

Historical

The removal of a child through an incision in the abdominal and uterine walls has been known since remote antiquity In the Hindu Vedas (Susrutas Agur-Veda) we find the suggestion made to open the abdomen of a pregnant woman immediately after she dies in order to save the child In the writings of the ancient Greeks and Romans we find allusions to removal of a child by a Cesarean operation The god Dionys, according to Greek mythology, was born in this way after Zeus had killed his mother Semele by a thunderbolt Numa Pompilius (715 672 B C), the second legendary King of ancient Rome, in his "Lex Regia" ("Royal law") makes it imperative to open dead pregnant women immediately in order to save the children Æsculapius, according to Ovid (Ovid Metamorphoses, Lib II, v 628–630) was born this way That the word "Cesarian" does not originate from the fact that Julius Cæsar was born in this way is evident, since Scipio Africanus (237–183 B C) who lived before Cæsar (100–44 B C) was born in this way, as may be seen from the biography of Scipio, written by the Roman historian Pliny

This operation was also known in the orient The great Persian poet Firdouzi (941–1020), in his poem Shahnama (the "Book of Kings," completed in 1010, A D) speaks about the birth of Rustam by a Cesarean section performed on his mother Rudaheh In order to alleviate the pain wine was given to her as an anesthetic The operation was known to ancient Hebrews, as may be seen from the description in the Talmud of "Jotze Dofan" (birth through the abdomen) In the medieval period Cesarean section was a well known procedure The Roman Catholic church advised to "remove the child cautiously immediately following the death of the pregnant mother If the child is alive it should immediately be baptized"

Shakespeare alludes to it at the beginning of the XVIIth century

"Macduff was from his mother's womb
Untimely ripp'd" (Macbeth, Act V, Scene VII)

It is frequently mentioned that this operation was performed by Jacob Nufer, a pig-gelder, on his wife, in 1500. However, many believe that this was a case of full term abdominal pregnancy. Today it is generally accepted that Trautmann, of Wittenberg, was the first who in modern times performed a Cesarean operation (in 1610) on a living woman with a hernia of the pregnant uterus.

Due to the fact that the uterus at that time was not sutured but was dropped back into the free peritoneal cavity, the mortality was extremely high, the patients dying usually from hemorrhage or peritonitis.

Suturing of the uterine wall was first suggested by Lebas in 1769. However, his work passed unnoticed.

Jörg, in 1808, suggested using a latero-posterior approach. This operation, "gastro-elytrotomy," consisted in making an abdominal incision above and parallel to Poupart's ligament down to (but not through) the peritoneum. Then, the peritoneum was pushed upward until the uterus was exposed, its wall was incised, and the child was removed. Ritgen, in 1821, carried out the suggestion of Jorg. Porro, in 1876, suggested a Cesarean operation followed by a supravaginal hysterectomy as a routine procedure (thus eliminating hemorrhage and infection from the escape of lochia into the free peritoneal cavity). Max Sanger, in 1882, gave his classical description of the conservative Cesarean section, and thus this procedure was placed on a safe basis. Since in Sänger's method the uterus is preserved, this method is known as the conservative Cesarean operation. In the case of the Porro technic the uterus is removed, and for this reason it is designated as the radical Cesarean operation. Frank, of Koln, introduced in 1907, the extraperitoneal method of Cesarean section.

Indications.

1. Pelvic contraction of a considerable degree (when the conjugata vera is less than 5.5 cm.). However, if the conjugata vera is less than 7.5 cm. normal delivery is hardly possible, so that many consider a size of the conjugata vera below 7.5 cm. as an indication for the Cesarean operation.

2. Tumor of the uterus or the adjacent structures blocking the delivery of the child.

3. Eclampsia (occasionally).

Cesarean section is reserved only for those cases in which quick delivery is necessary and when the cervix is narrow and elongated and the vagina small and rigid, when it would be unsuitable to employ methods of dilatation of the cervix. However, it should be mentioned that there are many obstetricians who believe that in the case of eclampsia the treatment should be medical and no surgery should be applied.

4 Placenta prævia.

Although the majority of obstetricians terminate the pregnancy in placenta prævia either by version or by the induction of labor by a dilating bag, nevertheless, some perform a Cesarean section

5 Diseases of the Heart

Not all heart lesions are equally dangerous Patients with mitral stenosis stand labor badly, next come those affected by aortic lesions, and finally those affected by mitral insufficiency To many obstetricians it seems better to subject the patient to a laparotomy than to a prolonged labor

6 Malposition of the fetus, especially in primiparæ

7 Previous Cesarean Section

This holds true if the previous Cesarean operation was performed for a permanent indication such as contracted pelvis with the conjugata vera less than 7 5 cm If, however, the previous Cesarean operation was performed for temporary reasons, such as placenta prævia, then some obstetricians would permit the patient to have a natural delivery in the hospital, being ready to intervene in case of signs of impending rupture of the uterus However, the majority of obstetricians believe that 'once a Cesarean section, always a Cesarean section"

Contraindications

a Dead fetus
b Presence of uterine infection
c Advanced labor with engagement of the head

Time of Operation

The best time to operate is a few days before the estimated date of labor However, if the labor has started but has not lasted more than a few hours, and if no vaginal examinations have been made, the Cesarean section is just as advisable

Subdivisions

Cesarean section is performed either by a transperitoneal route or by an extraperitoneal route In the transperitoneal variety it is performed, as a rule, with preservation of the uterus (conservative Cesarean section) Occasionally the uterus has to be removed after the child is delivered (radical Cesarean section—Porro operation, or its modifications)

I TRANSPERITONEAL CESAREAN SECTION

In the transperitoneal variety, the uterus may be cut either in the upper portion of the body (classical Cesarean section) or in the lower uterine segment ("low cervical section") There is quite a divergence of

opinion when to use the classical and when a low cervical Cesarean section. The majority of surgeons still believe that in the case of the elective Cesarean section, the classical operation is the operation of choice, leaving the "low cervical Cesarean section" only for doubtful cases in which infection is not excluded. However, there are many who consider that the

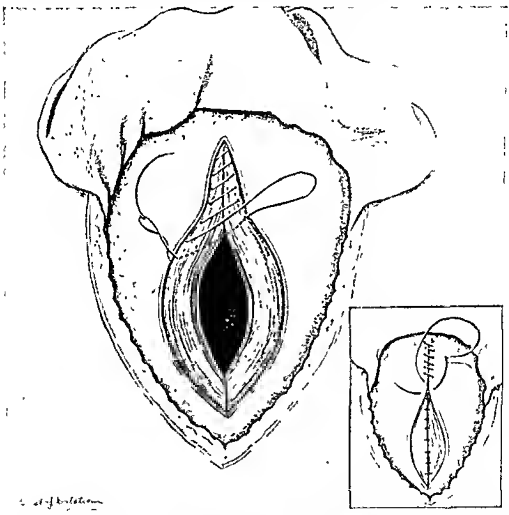

FIG. 355. Conservative Cesarean section. *Main picture*—Closure of the uterine wall after the child is delivered. Only the muscles are sutured (the decidual lining is not sutured). *Insert*—Suturing of the superficial layer of the muscle and the serosa.

"low cervical Cesarean section" should be the operation of choice and replace the classical Cesarean section.

a. CONSERVATIVE CESAREAN SECTION

Technic.

Step 1. An abdominal incision starts in the midline two inches above

the umbilicus and extends downward to the symphysis pubis. It runs semicircularly around the umbilicus to the left and then continues in the midline. [Some prefer to make the incision only in the lower half of the abdominal wall when the uterus is incised while *in situ*. The incision of the uterine wall should be just long enough to permit the delivery of the child. Others prefer to make a midline incision above only. The uterine wall is then incised in the upper portion of the uterus. After the uterus is evacuated it contracts below the level of the umbilicus, and therefore there will be no adhesions between the uterus and the anterior abdominal wall.]

Step 2. The uterus is pushed to the left in order to counteract the normal tilting of the organ to the right. Thus, the midline of the uterus will lie in the middle of the opened wound. Moist laparotomy sponges are introduced to "wall off" the uterus from the rest of the abdominal cavity. One ampule of pituitrin is now injected into the muscle of the uterus or of the arm, thus producing contraction of uterine musculature. A longitudinal incision is made in the midline of the anterior wall of the uterus, starting at the fundus. The length of this incision varies from 4 to 5 inches. Care should be taken not to incise the uterus too low, in order not to injure the bladder accidentally. However, the incision should be long enough to remove the child easily, since fast work is important between the time the uterine incision is made and the extraction of the child.

Step 3. The right hand of the surgeon is introduced into the uterine cavity. One or both feet are caught and the child is extracted. The cord is clamped by two forceps and cut between them.

Step 4. The uterus is now brought outside the peritoneal cavity and the placenta is removed.

Step 5. One of the assistants grasps the uterus close to the cervix and compresses the cervix on each side in the region of the broad ligaments, thus controlling the uterine arteries and diminishing the flow of blood while the uterine wall is being sutured. As the gloved finger slip, making it a difficult procedure to compress the cervix, this procedure is facilitated by wrapping a moist towel around the lower portion of the uterus and then compressing the cervix. However, many surgeons prefer not to do this, since contraction of the uterus takes place very quickly so that there is little or no hemorrhage.

Step 6. Suturing of the uterine wall is begun. This is done in two layers. The first layer of sutures grasps the deep layer of the muscle only (the decidual lining is not sutured), and another penetrates the serosa and the superficial portion of the muscle. The sutures are continuous (though many are using interrupted sutures) and of chromic catgut No. 2 (Fig. 355).

Step 7. The abdomen is closed.

b. LOW CERVICAL CESAREAN SECTION. (FIGS 356 AND 357)

This consists in opening the abdomen, exposure of the uterus, division of the vesico-uterine fold, and separation of the bladder from the lower

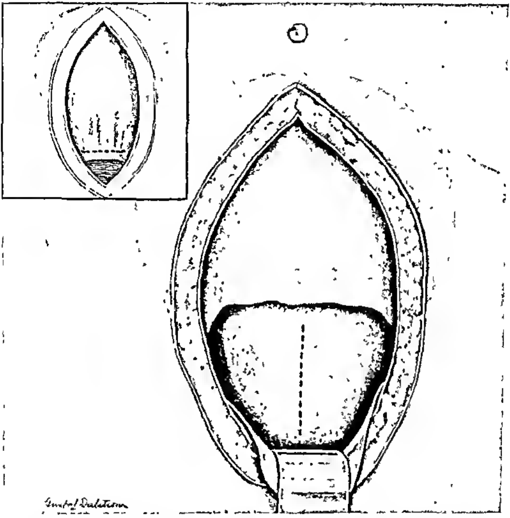

FIG. 356. Cervical Cesarean section. *Insert*—Dotted line shows the intended line of incision of the vesico-uterine fold. *Maine picture*—The bladder is retracted downward and the lower uterine segment is exposed; the dotted line shows the intended line of incision.

uterine segment, then in making either a longitudinal incision through the lower uterine segment (Krönig method) or a transverse semicircular incision (Kerr incision) (Fig. 356). The child is delivered, the placenta is removed, and the uterus is closed. The upper peritoneal fold is sutured to the lower, thus covering completely the suture-line on the cervix uteri (Fig. 357). However, in order to seal the suture-line on the cervix more

securely, some gynecologists suture the upper peritoneal flap to the anterior uterine wall below the line of uterine sutures Then the lower flap (the utero-vesical) is brought in front of the upper flap, overlapping its lower edge for a distance of one inch, and is sutured to it (Beck technic)

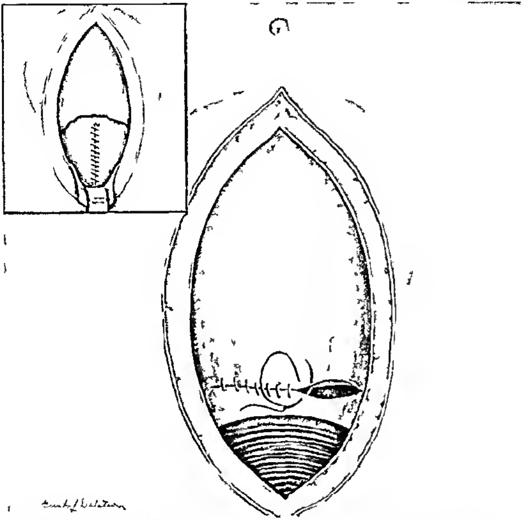

FIG 357 Cervical Cesarean section *Insert*—The wall of the uterus is closed after the child is delivered *Main picture*—Suturing the upper lip of the vesico-uterine fold to the lower one

c RADICAL CESAREAN SECTION (PORRO OPERATION)

When the uterus is infected (so that it would be dangerous to leave it in the peritoneal cavity), or when it presents some pathology which requires its removal (multiple myomata and fibromata, extensive hemorrhage into the wall of the uterus in the ease of premature separation of the placenta, so that it is evident that the contractile power of the uterus

is lost and hemorrhage is highly probable, etc.), the uterus is removed after the child is delivered.

The steps of the operation are the same as in the conservative Cesarean operation up to the point when the child is delivered. Then the technic differs. In the original Porro operation (which is rarely used now by any surgeon), an elastic ligature was tied tightly around the cervix. The infundibulopelvic ligament was cut between two clamps and the uterus cut above the elastic ligature and removed. The uterine stump then was transfixed by a knitting needle which was placed on the abdominal wall so as to prevent the stump dropping into the abdominal cavity. The abdomen was closed in layers. In a few days or longer the stump with the ligature sloughed away and the wound healed by granulation.

The original Porro operation is seldom performed now. If the uterus is removed today it is done by the usual method of supravaginal hysterectomy, and as the abdominal wall and the pelvic floor are relaxed it is frequently possible to bring not only the uterus but even the upper portion of the cervix outside the abdominal cavity, so that the performance of the supravaginal hysterectomy does not take more time than the removal of the placenta and suturing the uterine wall in conservative Cesarean section.

d. PORTES METHOD

Portes, of Paris in 1924, suggested a method of operation in cases of infected uterus. The full time pregnant uterus is delivered unopened outside of the abdominal cavity and the parietal peritoneum is sutured to the posterior surface of the lower uterine segment. The abdominal wall is closed. Then the uterus is opened, the child delivered, the placenta removed, the uterus sutured and left lying on the abdominal wall, wrapped in moist gauze. Five or six weeks later the abdomen is reopened and the uterus replaced. However, this method, we believe, will hardly appeal to the obstetricians.

II. EXTRAPERITONEAL CESAREAN SECTION

This method was suggested by Frank, of Köln, in 1907. Since that time many modifications have been suggested. The majority of gynecologists employ this approach only for doubtful cases, that is, when they are not sure that the case is clean (when they perform a classical Cesarean section), or is certainly infected (when the Cesarean section is supplemented by a supravaginal hysterectomy). To this group belong those patients who have been long in labor, or those on whom a manual vaginal examination has been repeatedly made, and also those patients in whom the membranes have been ruptured for a considerable time and unsuccessful attempts for delivery have been tried.

All the varieties of extraperitoneal methods may be classed into two groups

a Methods in which the peritoneum is not opened but is pushed upward in front of the lower uterine segment which segment is incised and the child delivered

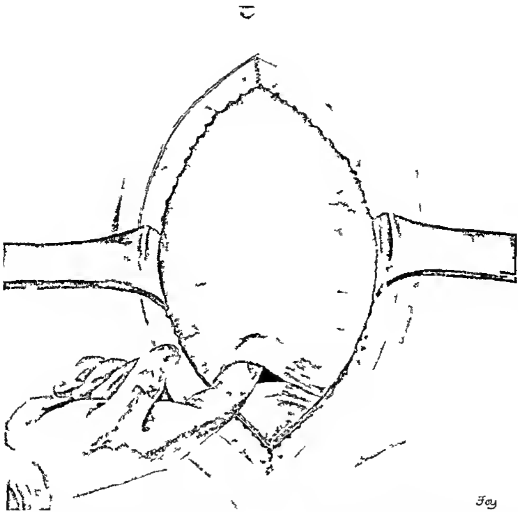

FIG 308 Extraperitoneal Cesarean section (Latzko method) Pushing the peritoneal reflection from the uterus onto the bladder upward thus exposing the lower portion of the uterus.

b Methods in which the lips of the incised parietal peritoneum are sutured to the lips of the incised visceral uterine peritoneum before the uterus is opened (so that extraperitonization of the uterus is effected before it is opened)

Whereas the first group of methods is truly extraperitoneal the second group is only extraperitoneal delivery by a transperitoneal route

a. EXTRAPERITONEAL CESAREAN SECTION (LATZKO METHOD)

From 100 to 150 c. cm. of any antiseptic solution is injected into the urinary bladder. This will raise the bladder above the symphysis pubis.

Step 1. A longitudinal incision extending from the umbilicus down

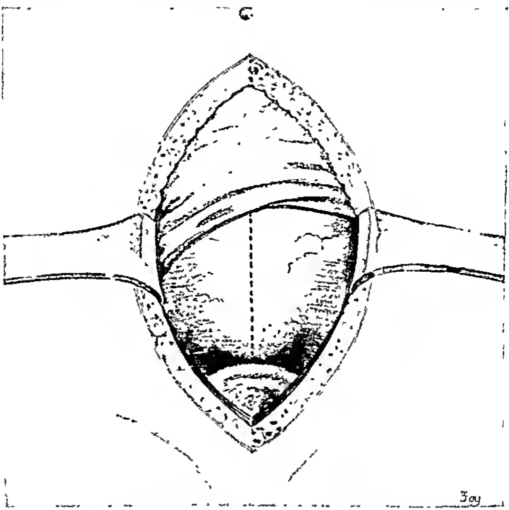

Fig. 359. Extraperitoneal Cesarean section (Latzko method). The dotted line shows the intended line of the incision on the uterine wall.

to the symphysis pubis (it may be a transverse incision) is carried down to, but not through, the peritoneum. The recti muscles are pulled apart. The parietal peritoneum is drawn upward. Thus the bladder is exposed. The bladder is then separated from the lower uterine segment by gauze-dissection and pushed to the right. The vesico-uterine fold of the peritoneum is then bluntly shoved upward until the upper portion of the cervix and the lower segment of the uterus are sufficiently exposed (Fig. 358).

Step 2. A longitudinal incision through the middle of the exposed uterus is made and the child delivered (Fig. 359). The placenta is removed, and the uterine wall is closed by catgut. The urinary bladder is dropped back, thus covering the suture-line.

Step 3. The abdomen is closed in layers.

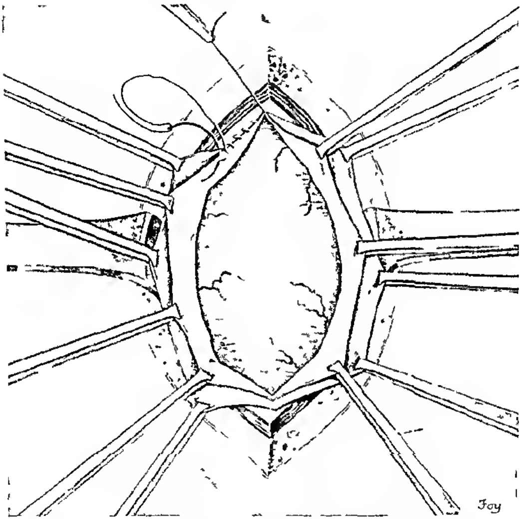

Fig 360 Cesarean section (Veit-Fromme method)

b, EXTRAPERITONEAL DELIVERY BY A TRANSPERITONEAL ROUTE (VEIT-FROMME METHOD)

Step 1. The abdomen is opened by a longitudinal incision extending from the umbilicus to the symphysis pubis.

Step 2. The visceral peritoneum of the uterus is cut longitudinally for the same length as the abdominal wall, and each lip of the visceral peritoneum is sutured to the corresponding lip of the parietal peritoneum.

In their original work the authors clamped the leaflets to each other. Hirst suggested suturing them before the uterus is opened (Fig. 360).

Step 3. The uterus is incised, the child delivered, the placenta removed, and the uterus closed.

Step 4. The abdomen is closed.

This method of extraperitoneal delivery through the transperitoneal route has the advantage over the true extraperitoneal route in this respect, that it gives s better exposure and there is less possibility of injury to the bladder. However, the methods of this group are not as safe (from the point of infection) as the methods of the first group.

H PELVIC SYMPATHECTOMY

That severe pain in the pelvic organs not yielding to any gynecological therapeusis, either medical or surgical, can be alleviated by cutting the sympathetic plexuses which represent the efferent pathways going from the genitalia, was known as early as the last quarter of the nineteenth century. To Jaboulay belongs the credit of being the first, who, in 1898, introduced as a surgical procedure resection of a small portion of the sacral sympathetic chain to eliminate pelvic pain. Ruggi, in 1899, suggested cutting the utero-ovarian plexus (running in the suspensory ligament of the ovary) as a measure for abolishing such pain. Leriche, in 1921, introduced peri-arterial sympathectomy of the internal iliac artery for the relief of intractable pelvic pain.

In 1925, Cotte suggested section of the superior hypogastric plexus (presacral nerve) for the relief of pain in the pelvis. This procedure in the great majority of cases relieves the pain completely, and since it is a much simpler procedure than peri-arterial sympathectomy it replaced the latter entirely.

Anatomy.

a. THE INNERVATION OF THE UTERUS

The sympathetic fibers of the uterus are derived from the hypogastric and *the sacral plexuses.*

The hypogastric plexus is the continuation of the inferior mesenteric sympathetic plexus. The latter gives origin to the right and left mesenteric nerves, which unite in one common trunk (or plexus) at a point lying one inch below the origin of the inferior mesenteric artery, and this place is the starting point of the hypogastric plexus. This plexus is subdivided into two parts: the superior hypogastric plexus and the inferior hypogastric plexus.

The superior hypogastric plexus (presacral nerve of Latarjet and Bonnet, who coiled this name) extends from its beginning at the level of the

fourth lumbar vertebra downward to the middle of the first sacral vertebra At this point it subdivides into two portions, the right and the left inferior hypogastric plexuses

The superior hypogastric plexus, in the greatest number of cases, actually represents a plexus (in about 80 per cent) and only in about 20 per cent it runs as a nerve Latarjet and Bonnet in their anatomical dissections evidently met the latter variety more frequently That is the reason why they called this the "presacral nerve", Cotte, in introducing his method of resection, used the name coined by Latarjet For this reason, this name is retained now However, we should bear in mind that resection of the presacral nerve is not a resection of a nerve-trunk but of a nerve-plexus. The superior hypogastric plexus runs in the midline and is separated from the middle sacral artery by a dense layer of fascia

The inferior hypogastric plexus (left and right) starts at the middle of the first sacral vertebra Its length is between two and three inches Each plexus runs along the medial side of the internal iliac artery Each inferior hypogastric nerve terminates in a hypogastric ganglion, which gives off some branches running laterally into the wall of the internal iliac artery, other branches running medially into the wall of the rectum, and some other branches coursing along the utero sacral ligaments [This is the anatomical explanation of relief of pain observed in some cases of retroversion of the uterus which were treated by cutting these ligaments It was believed before that this was due to a mechanical correction However, in the light of our modern knowledge we know that this was due instead to a division of the branches of the inferior hypogastric sympathetic plexus]

b THE INNERVATION OF THE OVARY

The ovarian sympathetic plexus is derived from the mesenteric and the renal plexuses It accompanies the ovarian artery Then it enters the suspensory ligament of the ovary and there it divides into a tubal branch going to the uterine tube and an ovarian branch going to the hilum of the ovary

Indications for Pelvic Sympathectomy

1 Severe pain due to inoperable malignant pathological lesions of the uterus or of the adenexa

2 Pelvic pain due to pathological lesions which do not yield to medical or surgical gynecological therapeusis

3 Functional dysmenorrhea not yielding to ordinary medical or surgical gynecological therapeusis

4 As a routine procedure in all pelvic conservative operations in which pain is a prominent pre operative symptom

TYPES OF OPERATIONS EMPLOYED FOR ABOLISHING PELVIC PAIN

The different procedures employed for the cure of intractable pelvic pain may be subdivided into four groups:

1. Section (or resection) of the superior hypogastric plexus (presacral nerve).

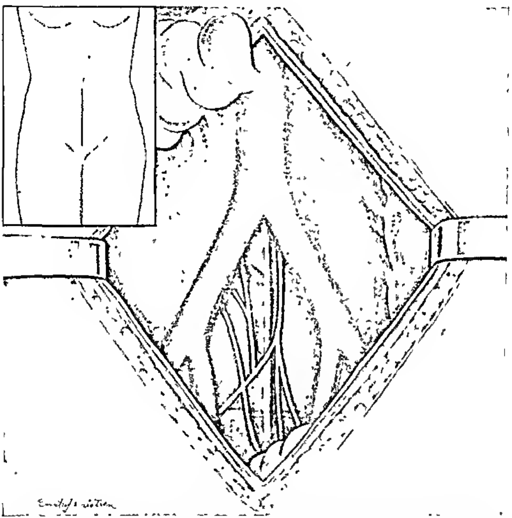

FIG. 361. Excision of the presacral nerve. *Insert*—Skin incision. *Main picture*—The sympathetic nerves known as the "presacral nerve" are seen shining through the posterior layer of the parietal peritoneum.

2. Denervation of the ovaries (section of the ovarian nerves).
3. Lower lumbar sympathectomy.
4. Peri-arterial sympathectomy of the internal iliac artery.

Resection of the presacral nerve abolishes the pain in the great majority of cases. As its technic is comparatively simple it should be given prefer-

ence to any other method of sympathectomy However, in extensive carcinoma of the pelvic organs accompanied by severe pain, it may be neces sary in addition to the resection of the presacral nerve also to resect the lower lumbar chain of sympathetics

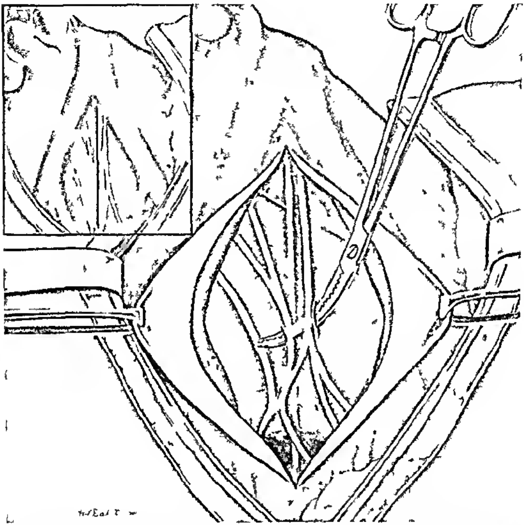

FIG 362 Excis on of the presacral nerve *Insert*—The parietal peritoneum is inc sed *Main picture*—Some of the fibers of the presacral nerve are separated from the posterior pelvic wall

TECHNIC OF THE RESECTION OF THE PRESACRAL NERVE (FIGS 361 AND 362)

Step 1 The abdomen is opened by a midline or a transverse incision (Fig 361, insert)

Step 2 The patient is placed in the Trendelenburg position The small bowel is pushed upward and packed so as to prevent its slipping into the pelvic cavity The lower sigmoid is retracted to the left (Fig 361)

Step 3. The promontory and the right and the left common iliac arteries are identified. The parietal peritoneum covering the anterior surface of the sacrum is incised for three inches in a downward direction in the median line starting from the promontory. Each lip of the incised peritoneum is caught and retracted laterally. Immediately beneath the reflected peritoneum and in front of the midsacral artery are seen numerous nerve-filaments which constitute the superior hypogastric plexus (the presacral nerve). These filaments are isolated and resected for at least one inch so as to preclude any possibility of a nerve-regeneration (Fig. 362).

Step 4. The lips of the incised parietal peritoneum are sutured.

Step 5. The abdomen is closed in layers.

TECHNIC OF COMPLETE PELVIC SYMPATHECTOMY

Step 1. The abdomen is opened by a midline incision starting one inch above the umbilicus and extending downward to the symphysis pubis.

Step 2. The patient is placed in the Trendelenburg position. The small bowel is isolated by packs so as to prevent its slipping into the pelvis.

Step 3. The posterior parietal peritoneum is incised in front of the aorta starting immediately below the origin of the inferior mesenteric artery. This incision is carried downward to the promontory and then farther downward in the middle of the concavity of the sacrum. The lips of the peritoneum are reflected laterally. The pre-aortic sympathetic plexus is isolated in front of the aorta and resected. The presacral nerve is isolated and resected. The right and the left lumbar sympathetic chains are isolated and at least two of the lower ganglia on each side are resected. [The right lumbar chain of sympathetics lies at the lateral border of the vena cava inferior. The left lumbar chain lies beneath the left border of the abdominal aorta.]

Step 4. The lips of the incised posterior parietal peritoneum are sutured together.

Step 5. The abdomen is closed.

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This Book

The SURGICAL TECHNIC *of* ABDOMINAL OPERATIONS

Fourth Edition Second Printing

By JULIUS L SPIVACK, M D

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